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VOL.18 NO.5 MARCH 9, 1999

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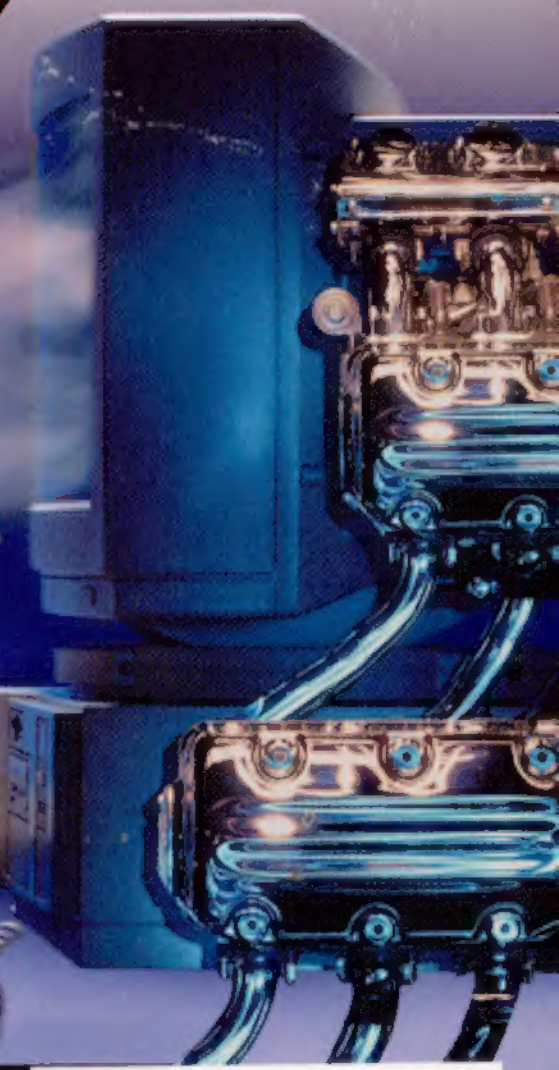

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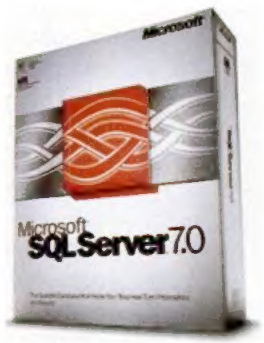

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Michael J. Miller

The Post-PC Era? Hardly...

Lately, I've heard a number of people talking about "The Post-PC World" or something like that. It's a great title for a speech; it indicates (correctly) that we're in an era defined by the personal computer, and that the era is changing. And they're right—technology is changing. But does that mean the PC is going away? Not a chance. Most of the people talking about the post-PC era should know better, and in fact, most do.

Almost no one expects PCs to disappear. After all, many people and lots of companies have tons of money tied up in personal computers and the applications that run on them. Those applications will be around for a very long time. Even if people stopped creating new applications today—and they won't—the existing applications and PCs would sustain a market for decades. In the Internet era, huge servers—descendants of mainframes from a generation ago—are becoming more important.

PCs won't disappear. Instead, the theory behind this "post-PC" line of reasoning is that the ascent of the Internet will make the PC somehow less important. This is more plausible, but I don't believe it.

If anything, the Internet is only making the PC more important. Personal computers remain the dominant device for accessing the Internet by far, and that isn't going to change any time soon. Nearly all important content on the Internet was created on personal computers, and PC technology remains a large part of hosting that content.

I don't believe the ascent of the Internet will make the PC somehow less important.

What's happening, though, is that the concept of the PC is changing. Most of us used to have just one or two PCs that we used on a regular basis: maybe one in the office and one at home, or else a desktop and a notebook. And that was it.

Now we're more likely to use many personal computers. At our offices, networks and Internet connections shared among personal computers are commonplace. Many of us have more than one computer at home, and home networks will become much more popular in the next few years.

We're also likely to have multiple devices capable of accessing the Internet. Though some of these look like traditional PCs, many don't. Some of us already have PDAs or personal organizers with Internet-access features. Some have cell phones that access the Net. Some have set-top boxes or other devices that plug into televisions.

Last month, Sun formally introduced Jini, a system for connecting all sorts of devices using Java and Internet protocols. It's not a new idea, but the concept is dead on: In the future, all sorts of things from toasters to TVs will be intelligent and hooked together.

Will these devices all be traditional beige-box PCs with Intel or Intel-compatible processors and Microsoft operating systems? Of course not. Many of these devices won't need or won't be able to support such features. As we move to an era of distributed intelligence, where even lights have rudimentary two-way communication features, you'll see lots of new software, new hardware, and new processors.

Yet despite that, many of these devices will be personal computers or will contain them. They may not all have Intel chips or Microsoft OSs, but they'll still fit the basic definition of a personal computer. Traditional PCs aren't going away—just the opposite.

Every major research firm sees sales of even narrowly defined PCs growing for years to come. After all, PCs remain the primary devices that people use to do the most interesting things on the Internet—from browsing to chat communities to electronic shopping. Faster bandwidth and huge advances in computing power should spur the creation of all sorts of new applications that only serve to make PCs more functional. I expect to see everything from videoconferencing to distance learning to unbelievable games and entertainment products in the next few years, and the bulk of these applications will target traditional PC desktops and laptops.

So is this the end of the PC era? Not a chance. Instead, it's the beginning of a new era, where the PC and the Internet work together to bring us all kinds of new opportunities. PC

PHOTOGRAPHY BY JAY REED

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COVER STORY

100 The Ultimate Upgrade Guide

PCs get less expensive every day, it seems, but sometimes upgrading the one you already have makes more sense than buying a new one. This special section tells you how to decide. And if you do decide to upgrade, we've got everything you need to know to make useful, cost-effective improvements to your current system and peripherals.

INTERNET

191 Online Auction Sites

No matter what you're looking to buy, someone is willing to sell it to you on the Web. Here we review the best sites for every kind of item. Let the bidding begin! *By Larry Seltzer*

HARDWARE

203 Combination PC Cards

A PC Card serving as both a network interface card and a modem can make using and traveling with a laptop much simpler. Here are seven "combo cards" to consider. *By Bruce Brown*

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IF ALL DISC DRIVES ARE THE SAME, WHY DO ALL TOP 10 SERVER BRANDS CHOOSE SEAGATE?

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Call toll free 1-877-271-3285
www.seagate.com/disc1

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	BARRACUDA 9LP & 18LP	BARRACUDA 18 & 36	CHEETAH 9LP & 18LP	CHEETAH 18 & 36
Capacity	9.1 GB, F & 18.2 GB, F	18.2 GB, F & 36.4 GB, F	9.1 GB, F & 18.2 GB, F	18.2 GB, F & 36.4 GB, F
Interface	Ultra SCSI (9LP) Ultra2 SCSI Fibre Channel	Ultra SCSI (18) Ultra2 SCSI Fibre Channel	Ultra2 SCSI Fibre Channel	Ultra2 SCSI Fibre Channel
RPM	7,200	7,200	10,000	10,000

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Organize Online

You may never again need to buy software for managing your calendar and address book. Instead you'll just go to the Web. Riding on the popularity of free e-mail, Web sites are starting to offer free services for maintaining and sharing meeting schedules, calendars, and address books.

The concept provides advertisers with a new way to target online consumers and a new avenue for e-commerce transactions. Web portals are jumping on the idea as a way to attract members and keep them coming back. "The Web-based calendar is wide-open territory right now. It's an untapped opportunity," says Ted Barnett, CEO of When.com—a start-up calendar site where you can track appointments, movie releases, television shows, concerts, and local-team schedules and set up group schedules.

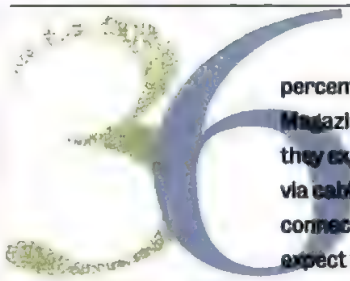
Web Calendars
www.calendar.yahoo.com
www.globalcalendar.com
www.jump.com
www.lycos.com
www.scheduleonline.com
www.when.com
www.mytime.com
www.supercalendar.com

Following in the footsteps of Yahoo!, one of the first portals to offer calendar services, Netscape recently announced plans to offer Netscape Calendar in conjunction with When.com. For synchronizing calendar and contact data with the Palm family of hand-helds, Windows CE devices, and other calendar applications, When.com has licensed Puma Technology's Intellisync. And Web portal Lycos recently launched MyTime.com in partnership with Web developer Amplitude.

Over at newcomer Jump!, you'll find personal calendars, reminders, group calendars, contact databases, e-mail, event listings, news, and synchronization to hand-helds via Puma's Intellisync. Meanwhile, the more business-oriented ScheduleOnline.com, developed by Jintek, is positioned as an intranet service for small and midsize businesses without the resources or desire to install a full-blown groupware application, such as Lotus Notes. Instead staff members can schedule meetings from any computer connected to the Web. The site automatically checks for conflicts in the schedules of invitees and sends out e-mail invitations and reminders.

Calendar sites plan to make money from ads, sponsorships, and e-commerce transactions. At Jump!, for instance, a birthday reminder may be accompanied by a promotion for a flower delivery service. And at When.com, book club members who receive listings of upcoming book launches can purchase the books directly from barnesandnoble.com. When.com takes you directly to the checkout counter with the selected book already in your shopping cart. When.com gets a percentage of the revenue from each purchase.

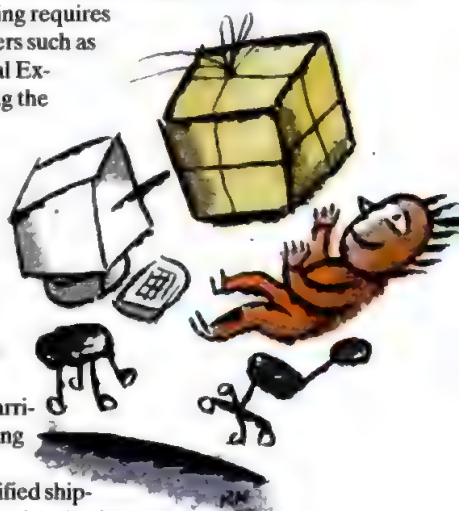
ILLUSTRATIONS BY FRÉDÉRIQUE BERTRAND (LEFT), ROBERT NEUBECKER (RIGHT).



percent of respondents to a recent PC Magazine Online poll told us that in 2000, they expect to connect to the Internet via cable modems. 30 percent expect to connect via 56K modems. Only 4 percent expect to connect via slow 28K modems.

E-Shopping, E-Shipping

The shipping business has been one of the major beneficiaries of the boom in e-commerce. In 1998 online shopping registered at $13 billion (with an average order amount of $55), and it's projected to reach $30 to $40 billion in 1999, according to the Boston Consulting Group. All this shopping requires shipping, and major carriers such as Airborne Express, Federal Express, and UPS are reaping the benefits.



Nevertheless, e-commerce buyers and sellers alike may find shipping and tracking their goods confusing. A new Web-based shipping service for online buyers and sellers, iShip.com, lets you compare rates and services across multiple carriers and find accurate pricing based on ZIP codes.

You can then print certified shipping labels and ship items using the drop-box, retail outlet, or carrier of your choice. iShip tracks packages and sends order-status reports to customers via e-mail. Merchants can also link iShip's shipping center directly into their Web sites. iShip, which tacks on an extra 50 cents per shipment, is currently targeting low-volume shippers but plans to provide for larger Web stores soon.

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Don't Miss Our Editors' Hot Links — Every *PC Magazine* evaluation now comes with a list of recommended Web sites. Join us online for one-click access.

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The Daily Download — Our shareware experts scour the ZDNet Software Library every day to bring you a notable pick.

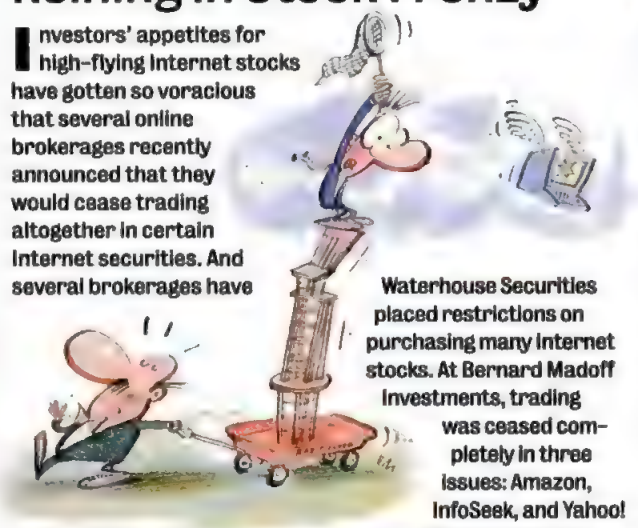
The Best of Palm Shareware — Head for our PC Tech section to download finalists from our annual Palm shareware contest.

Do You Get Bill Machrone's Newsletter? — Stop by our home page and sign up for our newsletter, featuring Bill Machrone's insights on new products. We'll send it via e-mail.

PIPELINE

Reining in Stock Frenzy

Investors' appetites for high-flying Internet stocks have gotten so voracious that several online brokerages recently announced that they would cease trading altogether in certain Internet securities. And several brokerages have changed their margin requirements (the amounts that they'll loan to investors to buy stock) to be more rigid in cases when investors want to borrow to buy Internet companies.



Recently Charles Schwab, which has processed as many as 100,000 Internet stock trades in the first hour of trading on certain days, announced that it was making margin requirements stricter for many Internet stocks. And following recent delays in order execution experienced by investors purchasing shares in Internet stocks, Waterhouse Securities placed restrictions on purchasing many Internet stocks. At Bernard Madoff Investments, trading was ceased completely in three issues: Amazon, InfoSeek, and Yahoo! Bear Stearns stopped trading in certain Internet securities as well.

As order executions during extremely volatile periods get hard to perform efficiently, the brokerages are put at more-than-normal risk of displeasing investors with off-the-mark executions. And the firms face situations where investors borrowing to buy stock may expose themselves to greater risk than they had anticipated.

Netscape officials have recently compared the demand for Internet stocks with "a modern-day land grab."

No More Windows?

The timing may be suspicious, since Microsoft is facing Department of Justice charges that the company has squelched competition, but Microsoft technical chief Nathan Myhrvold says that Windows will likely be replaced by another company's technology within five years. In an interview he recently gave to BBC Radio, he said that revolutions in the computer industry come about every five years and that the next operating-system revolution could come from any number of platform technologies, including Java and Linux.

Nathan Myhrvold

His predictions came just before Microsoft execs—in trial testimony—said that Microsoft has perceived several threats to Windows' dominance in recent years, including threats from Netscape and Intel.

ILLUSTRATIONS BY HAL MAYFORTH (LEFT), JACK GALLAGHER (RIGHT).

THIS ISSUE'S CONTRIBUTORS: *Bill Howard, Carol Levin, Sharon Nash, Sebastian Rupley, Don Willmott.*

VCRs Take A Spin

At least three companies—Replay Networks (*www.replaytv.com*), Sony (*www.sony.com*), and TiVo (*www.tivo.com*)—have solved an irritation that spares no TV watcher: interruptions. Example: You get up to answer the phone and you miss the last play of the World Series. With a new crop of VCR-like devices equipped with hard disks, you can take your break and not miss a beat.

The units let you "pause" a program, at which point the hard disk starts to save it. When you get back to the TV, you pick up where you left off. You can also enjoy your own instant replays, and you can choose your favorite shows in advance, then save them to disk automatically. Replay's and TiVo's new systems start at about $600 to $700. TiVo also has a monthly fee.

How much storage does a typical digital VCR offer? This varies. Replay Networks' first product, ReplayTV, will store 6 hours of recorded material; but 14 to 28 hours is in reach.

Look for the new devices to ship late in the first quarter of this year.

Top-Selling Retail Software

1. TurboTax Intuit
2. Microsoft Windows 98 Upgrade Microsoft
3. Deerhunter II 3-D GT Interactive
4. TurboTax Deluxe Intuit
5. Barbie Riding Club Mattel
6. Cabela's Big Game Hunter 2 Activision
7. Microsoft Flight Simulator Microsoft
8. Starcraft Expansion: Brood War Havas Interactive
9. Half-Life Havas Interactive
10. Barbie Photo Designer with Digital Camera Mattel

Source: PC Data. Data for December 1998.

Intel IDs

Intel recently got into hot water with several privacy groups over the Pentium III's unique processor identification numbers and random number generators, which are used in order to track and validate e-commerce transactions. The numbers identify the owner of a chip to a Web site when a transaction is to take place. Intel also produced a utility to let users erase their ID numbers, but that wasn't enough for some privacy groups.

Responding to protests, Intel scaled back its effort and decided to make use of the IDs voluntary. The Pentium III will ship with the feature disabled; customers can turn it on if they want.

Online Market Explosion

The Internet economy is finally hitting its stride. Sales forecasts for the various online industries are enormous. The greatest growth is expected in markets whose online potential has barely been tapped.

Online industry	1999 sales forecast (millions of dollars)	Growth over 1998
Travel	3,933	88%
PC hardware	3,106	46%
Books	1,138	75%
Groceries	350	137%
Music	281	108%
Videos	104	109%

Source: Jupiter Communications

Oracle Express analyzes 50 times more data than Hyperion Essbase.

	Data Density	*Query Execution Time*
Oracle Express 6.1	**5.0**	**0:34:02**
Hyperion Essbase 5	0.1	0:36:30

OLAP COUNCIL CERTIFIED

In a recent industry standard OLAP council benchmark, Oracle® Express® ran 250,000 queries against a data density of 5.0 and delivered an average response time of 0.07043 seconds. That's 50 times more data than the previous record. With a data density of 0.1, Oracle Express was 34% faster than the previous record. Oracle Express offers unparalleled scalability against the largest volumes of data. What's more, Oracle Express, combined with Oracle Discoverer® and Oracle Reports, delivers an integrated business intelligence solution, from reporting to ad hoc query and advanced analysis. When you want fast answers to hard questions, Express finds them—no matter how much data you have. Call us at 1-800-633-0510, ext. 18202, or visit us on the Web at *www.oracle.com/info/24* today.

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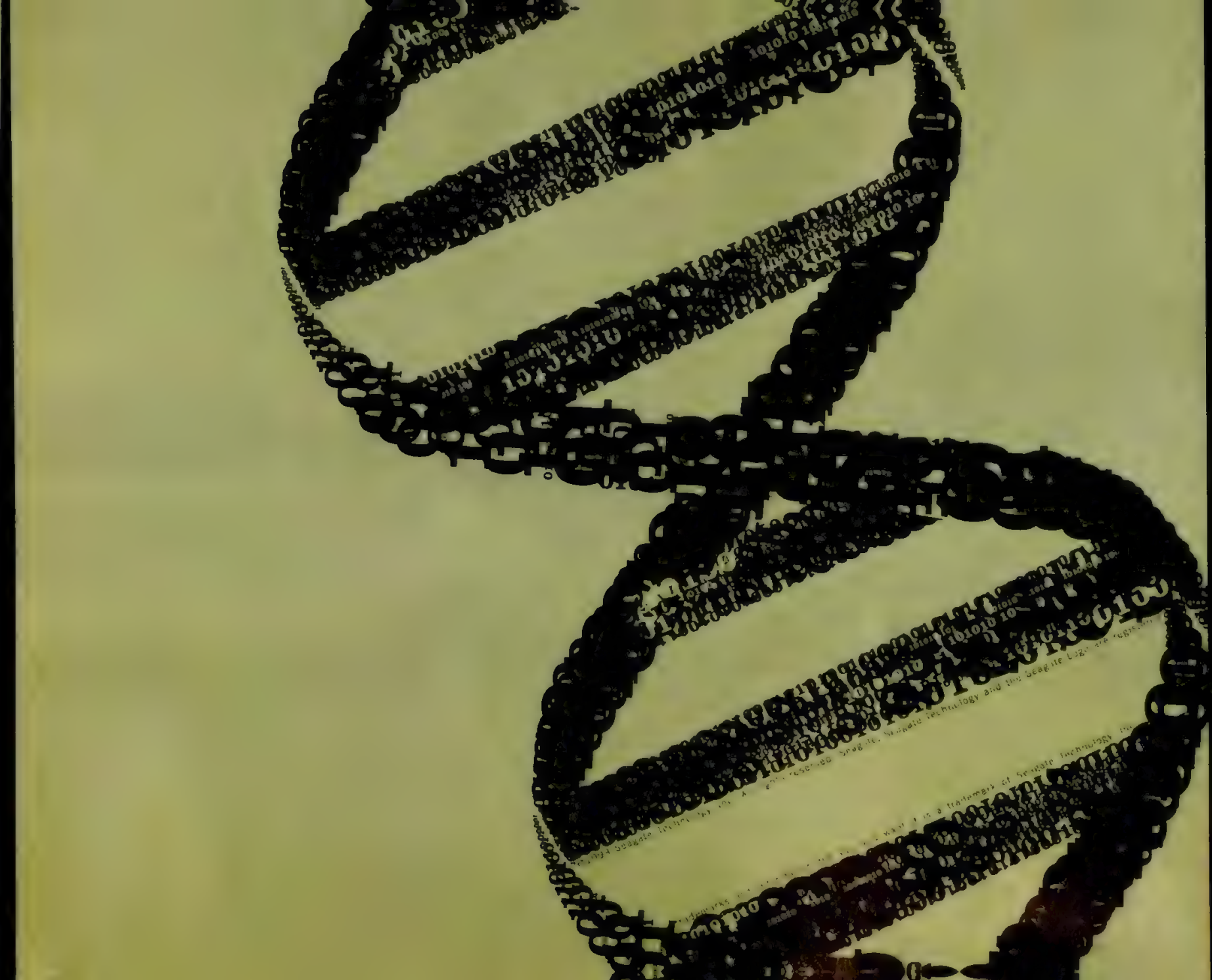

Disc drives that know their contents.
Disc drives that know when to back themselves up.
Disc drives that know there's a problem before it happens.
Disc drives that know how to manage themselves.

WHAT'S NEXT? DISC DRIVES WITH FEELINGS?

Uh, let us get back to you on that last point. But we're working on the first four. Get ready for disc drives with intelligence. Network-ready Seagate disc drives that can be attached to the network anywhere you want, independent of servers. Fast, reliable drives for manageable, scalable data storage. No matter how fast your network grows, Seagate storage solutions will keep you ahead of the game. Because the future of storage is being built right here. One drive at a time.

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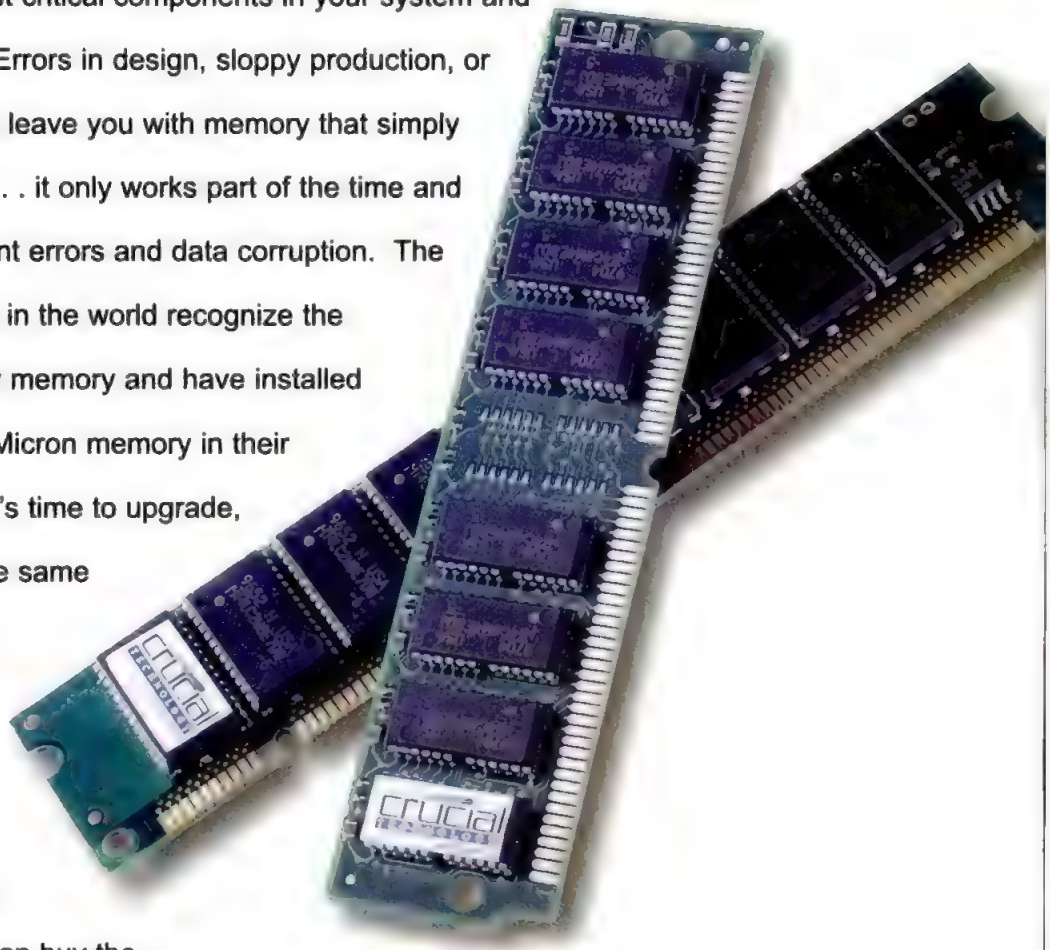

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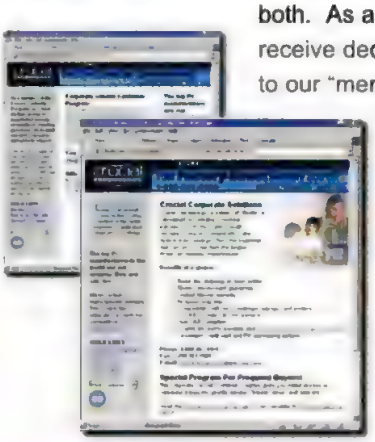

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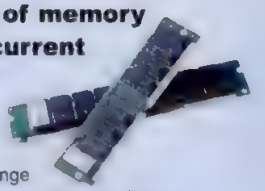

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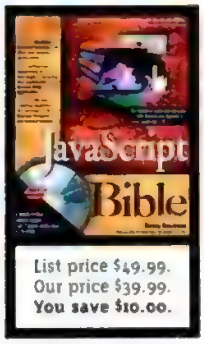

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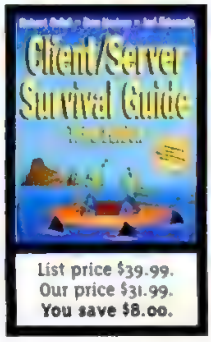

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LETTERS

FREE STUFF (MOSTLY)

Your story on the free software available on the Web (January 19, 1999) was extremely helpful. I also discovered a few other programs at some of the recommended download sites. Until I read this article, I hadn't realized that there was so much free software available. I had found a lot of shareware, but the amount of useful and productive freeware out there, especially in the audio production department, is fantastic.

MICHAEL D. BUCCA
via the Internet

If you are going to put "Free Software on the Web" on your cover, you should list software that is actually free. Of the items listed in the article, many cost money after an evaluation period. With so many useful tools, games, and other products available on the Internet that are either free of charge or "postcard-ware," why use such a misleading title? Either write an article about real freeware or call your story "Best Shareware on the Web."

ALAN SHEETS
via the Internet

There was a time when public-domain software was part of a substantial tradition of mutual assistance by microcomputer users. That seems to have faded somewhat, but there are those of us out there who still contribute and enjoy the contributions of others. Shareware isn't free; it costs. By failing to make much of a distinction between the two, you do a disservice to those who distribute freeware.

GREG DELOZIER
via the Internet

I got my January 19 copy of *PC Magazine* this morning and immediately said, "Yes! Finally some coverage of free software!" Imagine my disappointment when I realized that you had made the all-too-common mistake of assuming that PC equals Microsoft. I realize that the majority of your readership uses Windows, but the true free software (Linux, FreeBSD, and so on, and the thousands of programs for them) available all over the Internet warrants at least some mention.

SOREN HARWARD
via the Internet

PC Magazine *frequently covers non-Microsoft software. See our next issue, dated March 23, for more on Linux in particular.—Ed.*

DIGICAM DETAILS, PLEASE

It was with great interest and anticipation that I closely read the comparison of 20 digital cameras ("Closing the Gap," January 19). I was especially interested in comparing how these cameras transferred their images to the host computer. But I guess that as an imaging software developer, I am not in the same consumer market as those to whom the article was directed. At least some of the cameras come with Twain interfaces, ActiveX controls, and control APIs. Many digital cameras have serial interface ports that allow direct programmed control.

I'd find it really helpful if a future article, perhaps in the PC Tech section, could consolidate digital camera control information for readers like me who seek more than just packaged image-editor applications when buying digital cameras. Thanks for a great magazine.

STEWART DIBBS
via the Internet

E-BOOKS: NOT YET

I enjoyed Jake Kirchner's column on electronic books ("Save a Back, Save a Tree," January 19), but I have to disagree. Simply put, e-books require too much of a change in readers' habits and are too expensive. I'll compare this concept to that of a cell phone. If we had to pay the real price of the phones, few people would buy the service. Gillette figured it out long ago: Give away the razor to sell the blades. That's what the cell phone companies are doing. The makers of e-books will have to follow suit and give away the viewers.

> Until I read this article, I hadn't realized there was so much free software.

Although using a cell phone is a no-brainer, using an electronic book is a huge change for most people. I believe that e-books should be targeted at nontechnical users, but I can't imagine my mother-in-law reading her romance novels on one.

PAUL MACFARLANE
Santa Barbara, California

BAD AD

As I looked at all your awards so proudly displayed on pages 90 and 91 of the January 19 issue, I thought to myself, "Self, they should have the number-one award for accepting some of the lowest-class advertising I've seen in a long time."

I refer, of course, to the ad displayed on pages 62 and 63 for Buy.com. I'm hard-pressed to understand why a magazine of your quality would accept such trash. I'm disappointed, whether it matters or not.

PATRICK D. WILLIAMS
via the Internet

The opinions of our readers matter very much to us. Buy.com has agreed to reword its ad for future publication. We apologize for any distress this ad may have caused.—Ed.

PC HELP FOR THE VISUALLY IMPAIRED

My father is 70 years old and is interested in getting a PC. He would like to receive e-mail and send messages to his children, as well as "play" with other software and services. Unfortunately, his eyesight is very poor (he is legally blind). Could you advise me as to whether there are PCs and software for those with visual handicaps?

JERRY WRIGHT
via the Internet

You might try www.alternativefocus.com/products.html. *This site lists magnification software. Also, Windows 98 includes Accessibility features (located under the Accessories menu) that increase the size of icons and fonts. For e-mail, try a voice-enabled e-mail client such as Wizzard Software's VoicE-mail* (www.wizzardsoftware.com), *which uses the IBM ViaVoice speech recognition engine. Other, similar products are out there. You could also go with one of the remote, unified messaging solutions that read e-mail back to you (such as Webley Systems' Webley). Lots of these are available.—Ed.*

BUG'S LIFE

In your review of the O'Reilly Utilities for Windows 98 Annoyances (First Looks, January 19, page 60), you report that the software has a number of bugs in it, some of which are quite damaging. How can you then conclude, "The package is flexible and powerful enough to consider even before the fixes arrive"? As a software developer, I understand how hard it is to deliver a program that works perfectly. I don't think anyone is asking for perfection out of the box, but you should try for a little more consistency between your reviews and your conclusions.

FRANK W. ZAMMETTI
King of Prussia, Pennsylvania

TIP OF THE HAT TO SEYMOUR

A nod of approval to Jim Seymour ("Two More Win 98 Tips," January 19): I'm with you. Since the integration of the Quick Launch bar in Windows, my days of "icon creep" are over. No more searching through the clutter on the desktop or stacking all my favorites on the

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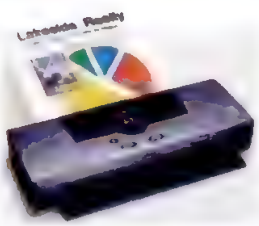

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LETTERS

Start menu. Thanks for reinforcing my obsession with an organized desktop.

KEVIN M. FRY
Groton, Connecticut

YOU SAY PBX, I SAY NETWORK

I would like to comment on "PC PBXs Come of Age" (January 5). I believe you misused the term *PC PBX*, making it interchangeable with *network PBX*. Network PBXs (such as the CrystaLAN system from Shoreline Teleworks) use distributed, network-based architectures that don't rely on a PC for a dial tone. You incorrectly placed the CrystaLAN network PBX solution into the category of PC PBXes, along with the others in the article. Availability and reliability are the reasons the terms *network PBX* and *PC PBX* cannot be used interchangeably.

I am happy to see that you have taken the first step in educating your readers on emerging telephony solutions. The next step is to help them correctly understand the different technologies available and their benefits.

STEPHEN P. MULLANEY
Vice President, Marketing
Shoreline Teleworks
via the Internet

We stated our views on the differences between networked PBXs and PC-based PBXs in the introduction, but our headlines were a little less precise. We do agree that this is a dynamic area.—Ed.

PRAISE IS IN ORDER

I just want to offer my thanks for Neil J. Rubenking's free utility MenuZap, described in the January 5 issue of *PC Magazine* (Solutions/Utilities). I had been wrestling with the Programs submenu of the Windows Start menu being "out of order" since Thanksgiving. Apparently, one of my family members accidentally rearranged the order of programs via the drag-and-drop feature.

I was beginning to think this might be a virus side effect, but thanks to Rubenking's description, I've ruled that out and am back "in order."

BILL JONES
via the Internet

CODE-DEPENDENT

I have always depended on your magazine to deliver much more than the standard fluff and marketing content all the others feed us. This became even more the case once I began programming, with Neil J. Rubenking's wonderful articles on utility applications and their accompanying code and programmer's notes. But now you've given in to marketing opinions and traded off excellence for mediocrity by banishing his work to the Web. You must realize what is more important than anything else in your business: valuable editorial content!

ROBERT MEEK
via the Internet

We hope you'll consider our Web site a vital part of your overall PC Magazine *experience and will visit it to read and download content that we agree is very valuable.—Ed.*

MEDIUM RARE

Regarding Bill Howard's column "Ten Trends for 1999" (January 5): I constantly see in magazines the question of which medium will replace floppy disk drives. Every opinion, including Howard's, is that it will be the Zip Drive, the Jaz Drive, or another cartridge device, especially among those that are backward-compatible with the floppy disk.

Backward compatibility is really not an issue. For the most part, floppy disks were not backward-compatible with themselves. The double-sided, double-density drives had trouble reading earlier formats unless they were written on the same drives.

The question then becomes, "What is currently the most-used medium?" The obvious answer is CDs. Every vendor that I do business with sends its software on CDs. CDs hold more data than floppy disks ever will, including the cartridges that everyone touts. And with the advent of rewritable CDs, the final argument for floppies becomes moot.

The CD-RW does everything a floppy disk can do and more, and prices for CD drives and disks continue to fall. It may not happen in 1999, but soon the floppy disk will disappear.

ROBERT A. MENGELKAMP
Las Vegas, Nevada

CHIPS AHOY

In his letter (January 19), Robert Fogel criticized your selection of the Matrox Millennium G200 as an Editors' Choice because he was unsuccessful in using it on his Super Socket Seven motherboard. The problem does not lie with the Millennium G200 but with the chip set used by the motherboard. That is not the fault of Matrox, which has built a card that complies with the AGP specification. But with the correct AGP driver for the motherboards, available from the manufacturer's Web site, Millennium G200 video cards can be used on all Super Socket Seven boards.

STEPHEN M. SIU
via the Internet

Your report on the Virtex chip ("Chips That Change Their Spots," Trends, January 19) seemed reasonable enough until the final sentence. That such a chip could lead to "one computer capable of running many operating systems" doesn't strike me as much of a breakthrough. A computer based on the Pentium/*x*86 family lets you run DOS, Windows 95 and 98, Windows NT, OS/2, Solaris, Linux, and so on. I think the real point is that it would let you run operating systems that were written for other chips.

DAVID C. JOHANNSEN
via the Internet

That's correct. Thanks for pointing it out.—Ed.

CD LABEL LAMENT

One hardware category I have not seen covered in recent PC computing magazines is that of CD label printers. I bought one last year for $1,200. A total rip-off, but the printer does work, and I am able to print CD labels. The company has a no-return policy and is not user-friendly, but it is one of the few vendors on the block and can demand what it wants. The prices for these printers are sky-high. As CD-RW technology becomes standardized, it would be nice to have a *PC Magazine* roundup of available CD label printers, along with your usual excellent Editors' Choices.

ERIC JOHNSON
via the Internet

Corrections and Amplifications

In our review "At Your Service" (First Looks, December 15, 1998, page 71), we incorrectly stated that only those on Portico's contact list could leave a telephone message with the service; in fact, anyone can. We also mistakenly stated that customer service representatives are available only during working hours; they are available seven days a week from 8:00 A.M. to midnight, eastern time.

In the Second Looks column "Love the Protection, Hate the Fees" (January 19), the URL for Symantec's knowledge base was misprinted. You can go to *www.symantec.com/techsupp/knowbase/index.html* and click to the NAV 5.0 information page.

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Fast-Forward to 2010

IBM's top visionaries imagine a future with holographic storage cubes, digital groceries, Internet everywhere, and easy computers.

Fast-forward five or ten years, and imagine how computer technology will be woven into your everyday life. Here's a glimpse of some of the products and technologies that are bubbling up inside IBM's research labs, plus a look at what that world will be like through the eyes of two of IBM's top strategists—Paul Horn, director of IBM Research, and Phil Hester, chief technology officer of IBM Personal Systems Group.

For starters, your refrigerator will know when you're running low on milk and remind your hand-held device so you can pick up a quart on the way home. At the grocery store, you'll pick up a few items, toss them in a bag, and leave; radio-frequency tags on the items will charge your account automatically. Your car dealer will detect car problems remotely and correct them by downloading software repairs directly to your car over an Internet connection.

Within the next one to two decades, you'll have a terabyte of storage in an economically affordable device (about $1 a terabyte) on the desktop. And a miniaturized, portable storage device will hold all the information in the Library of Congress. IBM's fundamental sciences group is now figuring out how to store and retrieve bits on a holographic storage cube, which provides significantly greater storage capacity than magnetic media.

You'll interact with appliances via speech recognition that will understand requests in context—not just type for you—and digital assistants will give you thoughtful advice. Computers and digital phones will have GPS capabilities, so you'll get information on products as you browse through stores. And as you're driving in the car, you'll get information on the restaurant that's around the corner.

ILLUSTRATION BY OCTAVIO DIAZ

DEEP COMPUTING

Then there are all the possibilities that "deep computing" opens up. With its genesis in IBM's work on the chess-playing computer Deep Blue, deep-computing technology focuses on analyzing data patterns and extracting useful information from vast databases. "*Deep computing* refers to things you never could have believed a computer could do," says Horn. "It will help us understand massive challenges such as the mapping of genes, accelerated design of life-saving drugs, and pinpoint weather forecasting."

For instance, understanding the human genome, which Horn considers the key mathematical problem of the next century, is a deep-computing task. Deep-computing techniques will be used as well in simulations of new medicines and chemical processes. Instead of designing drugs by mixing chemicals and feeding them to animals, scientists might create a drug and check its in-vivo efficacy on a computer. "The information in the gene databases will be more valuable than the drug itself," says Horn.

In the next generation of personal computing, everyone and everything will be connected to the Internet, but not through personal computers. Says Hester, "As wireless global communications expand and the cost of memory and semiconductors comes down, there will be a point where we can build task-specific mobile devices that can connect you regardless of where you are in the world."

Simplifying the personal computer is also a high priority. Researchers at IBM are now working on an interface that will recognize users visually and will present customized interfaces. For instance, an interface presented to a child will be different from an interface displayed for a parent. IBM's Hester sums it up best: "The PC is more complex than a lot of folks would like to deal with."

NO LIMIT IN SIGHT

Are there physical limits to advances in computer technology? "There's no immediate limit in sight for the next five to ten years. Bandwidth, storage, and compute power will all increase," says Horn. Tenfold to one-hundredfold improvements are possible without radically new approaches; beyond that, a fundamental change will be needed. One reason for the extended mileage is that the amount of power required in a compute step is less than previously thought. The amount of energy required to do one compute operation approaches the energy of the atom itself, Horn adds, and it's possible to store many bits in an atom.

The next question on his mind: How do you compute without using energy?

—Carol Levin

Tracking Web Music

Of the top five keyword searches on the Web search engines HotBot and Lycos, four are of an erotic nature. The fifth keyword is attracting a remarkable amount of interest without being even slightly risqué: *MP3*.

Compressing CD-quality sound by a factor of 12 while maintaining nearly the same fidelity, MP3 is currently the file format of choice in the ever-growing world of downloadable digital music. Nevertheless, other file formats, such as a2b and Liquid Audio, are challenging MP3's ascendancy. At the recent Digital Music Showdown in New York City, representatives from a2b Music, Liquid Audio, and MP3.com pinpointed file security—and its effect on music companies' profits—as a key objective for the industry.

TOP MP3 DOWNLOADS

"Moonlight Sonata" *(Richard Morris)*
"Need for Speed" *(Lucas)*
"Sex on the Beach" *(Neo-Gen)*
"Varsity Blues" *(sound track)*
"If You Believe" *(Vickie Wians)*
"Atomic Dance Explosion" *(Trance Control)*
"Anyplace I'm Going" *(Otis Rush)*

The most popular music downloads are primarily from independent artists willing to give their music away for free in exchange for widespread distribution.

Source: MP3.com; data for January 21, 1999.

Liquid Audio and 50 other software, hardware, music, and Internet companies—including Diamond Multimedia and MP3.com—have allied to form the Genuine Music Coalition. The Coalition will offer free utilities that place a Genuine Music Mark on any Liquid Audio or MP3 file, leaving a sort of watermark to prove that the music file is the genuine article. Such offerings will be compatible with the Recording Industry Association of America's Secure Digital Music Initiative, scheduled for delivery later this year.

MP3.com has also closed a deal for an $11 million investment from Idealab! and Sequoia Capital Partners, and it plans to continue trying to alter the power structure of the music industry by supporting independent artists and labels. Its cause may be aided by Lycos's new MP3 Search site (*mp3search.lycos.com*), which has searchable links to over half a million MP3 files. The site is avoiding copyright difficulties by providing lists of sites rather than content, but MP3 Search plans to keep users happy with improved search mechanisms and directories of bands and songs.—*Sharon Nash*

INSIDE PC LABS

The Sharper Image: Digital or Optical?

PC LABS

In this age of digital information, with so much attention given to the spec sheets on digital hardware components, it's easy to overlook the importance of analog (nondigital) parts. Our recent evaluation of digital cameras in the issue of January 19, 1999, taught us that not all "megapixel" cameras are alike. We learned that the quality of the optical lens is just as important as the pixel resolution—if not more so—in producing high-quality digital photos. At press time PC Magazine Labs is performing digital-video camcorder tests for an upcoming feature story, and they're also reminding us of the limitations of digital solutions in tasks such as zooming.

Vendors proudly label their digital cameras with the cool buzzword *megapixel*. But just as with traditional film cameras, the picture quality of a digital camera is only as good as what the lens delivers onto the image-recording medium—the million-pixel charge-coupled device (CCD) array, in the case of digital cameras. Merely throwing more pixels into the digital camera doesn't help if the lens can't sharply resolve the image.

In our recent roundup of megapixel-class digital cameras, PC Magazine Labs saw a wide variation in the quality of photos produced by cameras capable of the same resolution. One of our Editors' Choices, the Sony MVC-FD81—with the maximum resolution of 1,024-by-768—outperformed even cameras with more pixels, such as the Leica digilux (1,280-by-1,024), in the jury tests. In our Transition Pixel test, the Sony camera demonstrated a superior point-spread function, which correlates positively with the lens's resolving power.

Digital-video camcorder manufacturers also try to impress you with labels such as "100X Digital Zoom." But you have to read the fine print in the owner's manual to learn that such digital zoom results in a fuzzy image. While optical zoom involves changing the lens's position to magnify the image—as you would with a telescope—digital zoom blows up the image, which is digitized into pixels, by spreading the pixels apart and putting interpolation pixels between them, using algorithms such as B-spline interpolation. Digital zoom doesn't add more information to the photo—as optical zoom does—but provides the best guess, calculated with the algorithm.

A 4X optical zoom (above) refocuses the lens to deliver a magnified image that's sharper than a 4X digital zoom (below), which blows up an image by spreading the pixels apart and filling in the spaces with interpolated pixels.

Therefore, the image resulting from digital zoom is often of poorer quality than an image using optical zoom of the same magnification. Today many digital cameras and digital-video camcorders use a combination of optical and digital zoom. For the best picture quality, you should disengage the digital zoom.

You may have seen photographic wizardry in movies, such as *Enemy of the State*. A digital-graphics engineer zooms in on a surveillance camera image. The boss tells him to clear up a blurry face. After a few mouse clicks, what began as a very pixelated blur becomes a clear and identifiable face. It just doesn't work this way in real life. No digital component is capable of making up information that simply isn't there. —*S. Jae Yang*

PHOTOGRAPHY BY THOM O'CONNOR

MILLENNIUM BUG

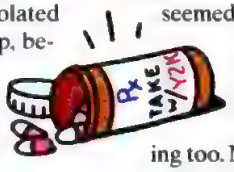
Here Now: Y2K

As the countdown to the year 2000 moves forward, early examples of the glitches computers may run into because of date fields that can't distinguish between "2000" and "1900" are already taking shape.

Doomsayers have been predicting that when January of next year arrives, computers everywhere will create chaos. What you may not know is that examples of isolated problems are already cropping up, because computers track data that will have pertinence in the future.

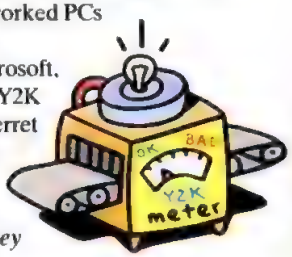
Recently *Scientific American* collected some of the Y2K problems that have already occurred:

- A Minnesota woman who is over 100 years old received an invitation to attend kindergarten in her hometown, following a computer error.
- Unum Life Insurance deleted hundreds of records from a financial reporting database after one of the company's computers mistook "00" in a date field for 1900.
- Amway Corp., which uses networked PCs to track the expiration dates of chemicals it mixes, had a string of chemicals rejected by the network because the expiration dates seemed to be in the year 1900.



As the pesky Y2K problem is already making a name for itself, the number of large technology companies looking to beat it is growing too. Netscape is working with the Defense Department to tie Y2K information to the company's portal site, Netcenter. Microsoft and Novell recently made several announcements regarding Y2K tools and training. Microsoft Y2K Product Analyzer, which looks over a PC's hard disk for year 2000 problems, is available for free at the company's Web site. Microsoft has also produced plug-ins for users of Excel 97, who may have Y2K problems in their spreadsheets. And the company's upcoming Systems Management Server 2.0 will let network managers automatically scan networked PCs for Y2K problems.

Novell, like Microsoft, has produced a free Y2K tool: Information Ferret lets users of Novell software scan for year 2000 problems.



—Sebastian Rupley

Y2K Without Fear

Jake Kirchner

We are all hearing many nightmarish scenarios about the possible effects of the year 2000 bug. But as far as I'm concerned, the worst Y2K damage has already occurred: Because of uncertainty and outrageous fear mongering, there is in our society a pervasive fear of the future.

All the talk of the millennium centers on the bad things that might happen to all of us. When we should be looking for reasons to be hopeful about reaching a significant milestone in the history of humankind, we're consumed with anxiety. And not because of war or disease or hunger. Rather we're consumed with fears about what harm our everyday appliances will do to us.

I'm not talking about fundamentalist groups who see millennial portents of the end of the world or about waiting-for-the-mothership-to-return cultists who are heading for the caves of New Mexico to await doomsday. I'm talking about average citizens, who are reasonably confident we'll survive the turning of the calendar but who also are pretty sure we will suffer some technological pain in the process.

The truth, however, is that when we hit the year 2000 nuclear missiles will not fire randomly, planes will not fall from the sky, the financial system will not collapse, and we won't be plunged into months of deadly winter power outages.

You hear a lot of people warning that the Y2K bug will make our computers unreliable. Since when have computers been reliable anyway? Mine are full of bugs. I can handle one more. This doesn't mean there isn't serious work needed to update much of our hardware and software, as the report above indicates.

But the truth remains that whatever disruptions occur because of this problem will be minor and scattered. If next winter is anything like the one just ending—with power outages, transportation shutdowns, and deaths caused by ice storms, heavy snowfalls, and floods from one end of the country to another—we probably won't even notice any Y2K effects. We'll be too busy coping with Mother Nature.

Speaking of which, if you consider the everyday threat of hurricanes in Florida and the other Gulf states, tornadoes in the central U.S., subzero temperatures and snow across the northern part of the country, freezing rain and ice from Maine to the Carolinas, and earthquakes and mudslides on the West Coast, you have to conclude that just about every American should already be prepared for short-term power outages and disruption of commerce and government services.

Folks, if you've taken the reasonable precautions that reasonable people take every day—acquired extra batteries, stocked food and water for at least several days, and backed up vital documents and records—you've probably done everything you need to do to prepare for whatever the millennium may throw at us.

The millennium should be a time of hope. The Cold War is over. We haven't had a world war in over 50 years. There are significant advances in medicine and agriculture. We're concerned about overpopulation and global warming, but we still believe we have the wherewithal to deal with those problems. And yes, technology is still on the whole a very positive influence. In fact, we can't solve our problems without it.

As we get closer to the end of 1999, you can look to the future with equanimity. You don't need to buy weapons, amass gold bars, or stockpile rice and beans. Above all, you don't need to be afraid.

ILLUSTRATION BY STEPHEN SCHUDLICH

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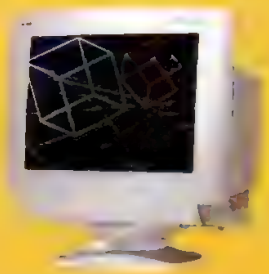

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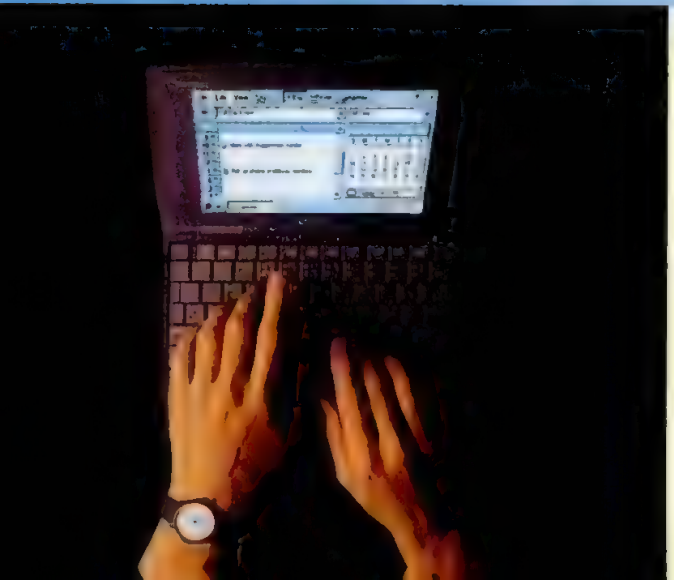

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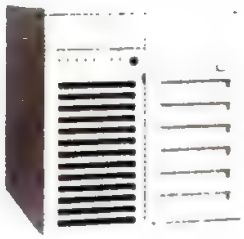

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DISPLAYS

5 Million Pixels, And Counting

You're late for an important meeting, and you're not quite sure how to get there. Imagine calling up the address on your on-screen map and actually being able to see all the streets and landmarks in detail.

Or you're a trader and you need to digest information from six different screens at once. How much easier would it be if the text and figures were clear and crisp from a distance? Or picture yourself examining your own X rays in detail on a computer screen.

IBM's new Roentgen display, an ultra-high-resolution active-matrix LCD that's just now making its way out of the research lab and into high-end applications, offers all that. But you'll have to wait a few years before it reaches your notebook.

Intended initially for medical imaging applications, the Roentgen (named after the discoverer of the X ray) has some impressive specifications: The 16.3-inch display has a resolution of 2,560 by 2,048 pixels (over 5 million pixels). That's 6.7 times as many pixels as an XGA display (1,024 by 768 pixels) and 4 times as many as a Super XGA (1,280 by 1,024 pixels).

To illustrate the vast improvement another way: A typical desktop monitor has 80 to 100 pixels per inch (ppi), while the Roentgen has 200 ppi. That means a 10-point character has four times as many pixels as the same character on a CRT monitor, resulting in sharper edges and a crisper image. All those extra pixels produce more detailed letters and make reading on-screen easier on the eyes. According to IBM, the extra detail is especially useful for reading ideogram-based Asian languages.

One of the breakthroughs that enabled the researchers to pack more pixels into the display involved the use of aluminum and copper instead of traditional display metals molybdenum and tungsten. Aluminum and copper are better conductors and allow the resolution to rise and the price to drop.

The Roentgen will be sold initially as a standalone display at $5,000 to $10,000 by the end of this year or early 2000. Since the Roentgen uses the same basic manufacturing techniques as current high-end LCDs, once the production volume increases IBM expects that the price of the Roentgen will match that of a current high-end notebook display. IBM has not set a specific date for using the display in high-end ThinkPads, but they're the display's ultimate destination. The major stumbling block as far as getting the displays into ThinkPads earlier, explains Robert Wisnieff, manager of the advanced display technology laboratory at IBM's Thomas J. Watson Research Center, is that the Roentgen's power usage is currently half as efficient as that of existing notebook displays.

Robert Wisnieff, manager of IBM's Roentgen project, demonstrates the display's ability to show extremely detailed images, such as X rays.

	IBM ThinkPad 770Z	Roentgen
Diagonal viewing area (inches)	13.3	16.3
Resolution	1,024 x 768	2,560 x 2,048
Number of pixels	786,432	5,242,880
Pixels per inch	[illegible]	200
Transistors	2.4 million	15.7 million
Thin-film wiring	0.26 miles	1.64 miles

But you may not have to wait so long to see a clearer picture. Microsoft has also been working on improving display resolution, but it has taken a completely different approach. Its ClearType technology is a software-based solution that's designed to upgrade existing notebook displays. ClearType uses signal-processing techniques in order to sharpen up text at the subpixel level. According to Microsoft, it improves notebooks' display resolution by 300 percent.

—Sharon Nash

E-COMMERCE

The Online Complaint Window

The numbers for the fourth quarter of '98 have rolled in from e-commerce sites, and the news is bullish. Holiday buying shot through the roof, and stock market investors sent shares in the companies running these sites skyward, on a scale the world rarely sees.

According to data from ZD Market Intelligence, more than 30 million American adults at least browsed the shopping sites on the Web over the holidays, and more than 8.2 million of them bought cyberwares—at least $2 billion worth. Market researchers at Jupiter Communications peg that number at over $3 billion. But even though the age of e-commerce has arrived, concerns are arising about customer service and reliability.

"The combination of retailers that launched or relaunched their sites within weeks of the holiday season, coupled with the significant, unanticipated increase in traffic, led many sites to underperform," says Nicole Vanderbilt, senior analyst for Jupiter Communications. "Companies spent considerable dollars to acquire the customers that visited their sites. If they don't shift their efforts to alleviate technology issues and improve customer service in the coming months, they risk losing the customers they spent so much to acquire."

HOLIDAY*RUSH*

Adults who browsed online for wares: **30 million**

Adults who bought online: **8.2 million**

Amount spent online by adults: **$2 billion**

In a Jupiter customer-satisfaction survey of 2,300 U.S. households, lack of merchandise availability was frequently cited as a problem, with 15 percent of respondents complaining about empty cybershelves. The cost of shipping and handling was also a significant source of dissatisfaction, with 14 percent of Jupiter's respondents grousing about it. Slow site performance was also high on the list, drawing complaints from 13 percent of respondents.

All of this raises concerns about keeping shoppers attracted to online stores. Jupiter's analysts say that only 37 percent of respondents said they would spend more money online next holiday season than this season. Jupiter analysts consider this an "alarmingly low" number. More than half the respondents said they would spend the same amount next time, and 5 percent said they would spend less.

—Sebastian Rupley

Palm-Size PCs: Now in Color

Adding color to a palm-size PC may seem like overkill, but preproduction versions of two upcoming Windows CE hand-helds—the Compaq Aero 2100 and the Hewlett-Packard Jornada 420—demonstrate the advantages of color, even on small screens. You can expect to pay a $100 premium for a color display rather than a monochrome display.

Code-named Wyvern by Microsoft, the operating system for the color palm-size PCs is the latest revision of the Windows CE platform. In addition to support for 256 colors and 240-by-320 resolution, other enhancements include TrueType fonts instead of bitmap fonts and rechargeable batteries.

With an eye to enterprise customers who may want to develop applications, Wyvern also includes support for Visual Basic, Active Data Objects (a database layer that enhances communication between an application and database), and Microsoft Foundation Classes (a common command library). Manufacturers can offer support for those features on ROM (using approximately 650K) or provide the tools on-disk for loading into RAM, although the latter method decreases performance, according to Microsoft.

The first-generation monochrome palm-size Windows CE devices cost about $400 with 4MB of RAM. Expect to pay about $500 for a color model, likely with 8MB of RAM or more. The Compaq Aero 2100 will be available in March. The HP Jornada 420 will ship in extremely limited quantities in February, with wide distribution in March.

Models and bundles: The Compaq Aero 2100 will come in three versions, two of them with 16MB and one with 8MB of RAM, each based on an 80-MHz NEC MIPS R4000 processor. A 16MB version with a docking cradle/recharger, lithium ion battery, and slipcase will sell for $499. At press time prices haven't been set for the 8MB Aero 2100 and the second 16MB model, bundled with an extra battery and a fancier carrying case.

The HP Jornada 420, which is powered by a 100-MHz Hitachi SH-3 processor, will sell for $519—including a docking cradle/charger and one lithium ion battery—and will come in just one version, with 8MB of RAM, expandable to 16MB.

Size and weight: The preproduction units we tested are roughly the same size, and each weighs 9.2 ounces with battery. Final-version ratings are 8.8 ounces for the Jornada 420 and 10.9 ounces for the Aero 2100. The silver-colored Aero 2100 measures 0.8 by 3.3 by 5.3 inches (HWD), and the dark-purple Jornada 420 measures 0.9 by 3.2 by 5.1 inches. The Jornada 420's measurements include a clear flip cover, similar to the opaque one on the 3Com Palm III, which simultaneously protects the display and lets you see the contents.

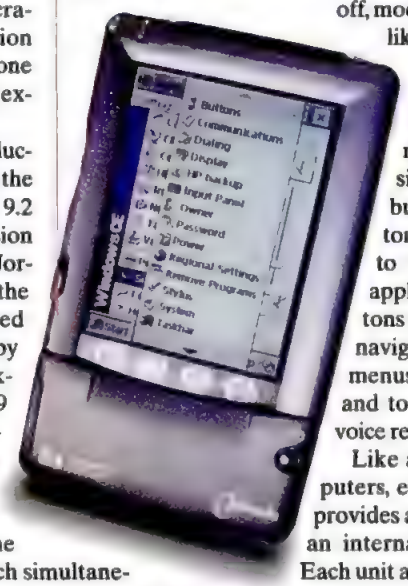
COMPAQ AERO 2100
www.compaq.com
- 256-color display
- 80-MHz NEC MIPS R4000
- 16MB RAM
- 10.9 ounces
- $499

Display size and quality: The displays are 2.4 inches wide by 3.2 inches high. The power-on buttons are also used to increase screen brightness, with one brightness level for the Jornada 420 and two levels for the Aero 2100.

While shipping versions may vary from our samples, the backlit passive-matrix display on the Jornada 420 we saw is significantly brighter than the reflective TFT active-matrix display on the Aero 2100. In each case, color makes it easier to view data elements on the screen. (Certainly playing solitaire is easier in color than in monochrome!)

Battery power: Both models use internal lithium ion batteries. The Jornada 420's battery is rated at roughly 6 hours of continuous operation. Compaq hasn't finalized battery ratings at press time, but it expects the Aero 2100 to last for 6 to 10 hours. Note, however, that these battery ratings are calculated based on display brightness that's turned down or off, modes that you're unlikely to use.

HP JORNADA 420
www.hp.com
- 256-color display
- 100-MHz Hitachi SH-3
- 8MB of RAM
- 8.8 ounces
- $519



Controls and connectivity: The controls on the two new hand-helds are similar: Each has buttons on the bottom front of the case to quick-start major applications, plus buttons on the left side to navigate and select menus and applications and to control the unit's voice recorder.

Like all palm-size computers, each of these units provides a touch screen with an internally stored stylus. Each unit also has a CompactFlash Type II slot and an infrared port. Both the Aero 2100 and the Jornada 420 have serial ports on their docking cradles. While both models have microphones, tiny speakers, headphone jacks, and alarm LEDs, the Aero 2100 also has a vibration mode for schedule alerts.

Bundled software: Neither Compaq nor HP is including Visual Basic, Active Data Objects, or Microsoft Foundation Classes support in ROM in their shipping models. The Aero 2100 includes Compaq Asset Management in ROM for use on networks and in corporate environments. Beyond the standard Windows CE for palm-size PC software, Compaq has not finalized software plans at press time. The Jornada 420 will ship with HP Backup, the business calculator OmniSolve, and the application navigator bTASK in ROM; it will also include Trio PhoneManager 2.0 for SMS messages, Quicken ExpensAble, and Inso's e-mail attachment viewer Outside In on CD-ROM.

—Bruce Brown PC

PHOTOGRAPHY BY THOM O'CONNOR

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intel inside
pentium II

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Mobile Computing & Communications November 1998

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Less Taxing Taxes

These products make tax time easier and more organized—and they might even save you money by pointing out missed legal deductions.

By Kathy Yakal

Tick, tick, tick. Time's run out for accruing your 1998 income and expenses, and you've got to pony up. Once again, though, there's help—tax preparation software that guides you through putting all the numbers in the right places and encourages you to ferret out every legal deduction possible. We also look at a Web site that does the same, sans some of the tools and guidance found in the shrink-wrapped boxes, and we reexamine e-filing.

The usual suspects—Block Financial Corp.'s Kiplinger TaxCut and Intuit's TurboTax—are back, and they're better than ever. Block took a less-is-more approach this year, toning down the flash of its program's interface while carving more flexible, understandable tools for frazzled taxpayers. TurboTax also presented a quieter face this year, but it has interface changes that should make your mazelike tax preparation experience less frenzied.

Both products offer similar options for preparing your taxes. If you've used this kind of software before, you know the drill. You can import your carefully categorized Money and Quicken financial files into both products.

You can also enter new data directly on the on-screen forms and schedules provided (more than 100 of the most common documents are included) or let the programs control the procedure via an easy interview-like method: TaxCut and TurboTax display question after question on the screen, related to your income and expenses, then drop your answers in the right places on the return.

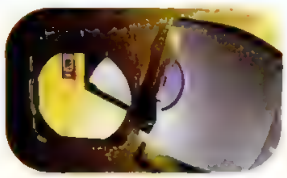
You can move through your 1040 sequentially or choose your own path. Interactive topic lists in the interview show you where you've been and what's left, and you can revisit topics or jump ahead. Clarification and guidance are abundant, thanks to videos, tons of text-based explanatory text, and verbatim IRS instructions (the amount of guidance varies among different versions of the tax products).

When you're done, the programs scour your return for potential problems and erroneous data and let you correct them. Then, poof! Either print out your 1040 and related documents or follow the software prompts to file electronically.

Both TaxCut and TurboTax lean more on the Web this year. You can download program updates (a very critical ability with tax software) and do some or all of your tax preparation online.

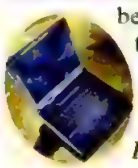
Uncle Sam is making it easier to file and even pay tax obligations electronically. Selected users of last year's tax products received a special identification number that lets them file electronically without mailing in any paper. Also, you can specify a date (through April 15) for your owed tax amount to be debited from your checking account and even use certain credit cards to pay your debt (Novus cards and others, depending on the program).

Microsoft made some noise about jumping into the fray with a tax prep product of its own but later demurred. There is another new offering this year, cour-



MAKE SOME NOISE: The long-awaited, diminutive Iomega Clik! drive offers up a new storage standard that's flexible and inexpensive. *Page 48.*

AFFORDABLE PORTABLES: PC Labs puts two new Celeron notebooks through our benchmark tests. Do they measure up to the pricier Pentium IIs? *Page 56.*



NETWORK DECODER RING: Neon Software's CyberGauge for Windows promises to decipher and report the cryptic network traffic information that your router already provides. *Page 76.*

More Products Reviewed

HP CapShare 910 49
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First Looks Online

For daily just-in-time reviews of shipping products, check out First Looks Online at

www.pcmag.com

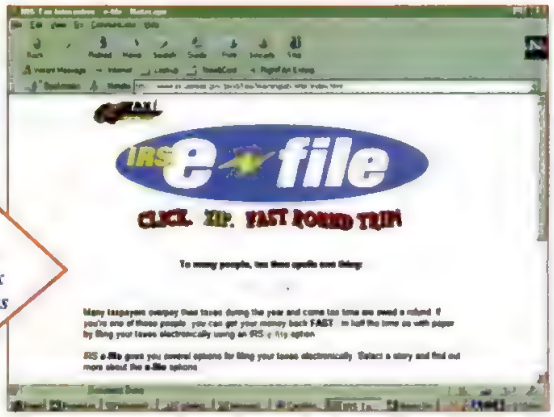
ILLUSTRATION BY CHRIS PYLE

tesy of some of the same people who brought you the now defunct Personal Tax Edge. TaxACT (*www.taxact.com*) is off to a good start. You can download it free of charge at the site, and $9.95 brings you more features in a deluxe edition (see the sidebar below for an evaluation of the software).

E-FILING

If you think electronic filing of personal tax returns is just a cool way to use technology, think again. To the Internal Revenue Service (*www.irs.ustreas.gov*), e-filing represents savings of time and money, not to mention a boost in accuracy (less than 1 percent of returns filed electronically contain errors). For the consumer, e-filing is the fastest way to get a refund, and it costs little or nothing.

Last year, approximately 25 million taxpayers filed their returns electronically, roughly a 28 percent increase over 1997. But despite that impressive growth, e-filing still has a lot of hurdles to clear before the IRS reaches its goal of 80 percent of returns filed electronically by 2007. Progress is being made this year, however, with the help of such tax preparation software companies as Intuit.



THE FRIENDLY IRS: *Its Web site contains a wealth of information on topics such as e-filing, tax law changes, and business tax regulations.*

Previously, only filers anticipating refunds could file electronically. A pilot program introduced this year lets select tax-software filers use certain credit cards (primarily, Novus cards such as Discover) to pay balances due. Computer filers can also arrange to have the funds they owe withdrawn from their savings or checking accounts, up until April 15. Further, any filer can call 888-272-9829 to charge owed taxes to American Express, Discover, or MasterCard.

Another pilot program takes away an annoying hurdle from the paths of prospective e-filers. In years past, e-filers were required to submit paper documents: W-2s, 1099s, and an 8453 form (a brief document that includes your signature for verification). For the 1998 tax year, some prior users of tax preparation software received an e-file customer number (ECN), a digital "signature" that relieves them of the need to mail in extra paper. This year, too, e-filers will receive an electronic time- and date-stamp receipt that indicates when their

2nd Story's Tax Software: A Class ACT

A new product was announced late last year that could provide real competition to TaxCut and TurboTax. TaxACT, from 2nd Story Software, was created by former employees of Parsons Technology who were involved with the development of Personal Tax Edge. In some ways, this new product is better than the one Parsons put out after years of development. TaxACT offers fewer forms and schedules than TaxCut and TurboTax, doesn't yet import data from other financial programs, and lacks the depth its competitors have built up—particularly in terms of taxpayer assistance—but it's a great first effort. Better yet, it's free.

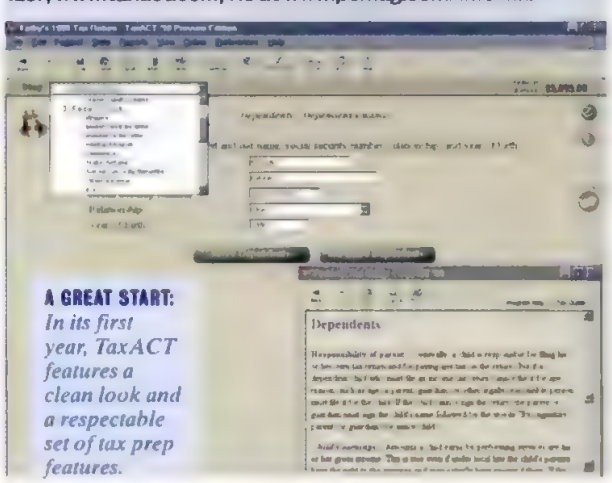
Like its competitors, TaxACT offers both question-and-answer and direct forms entry. The Q&A asks questions and provides fields for answers in a box, dropping your responses in the correct fields in the active form displayed below. If you opt for direct forms entry, you can enter supporting details for fields in the box provided. If the folder icon next to a field is lit up, you can see a list of forms and schedules that feed figures into that field and jump to the correct one.

At cleanup time—when you're ready to move on to audit and review tasks—TaxACT sniffs out the same kinds of problems that its competitors do. State income tax forms are available, and you can either print your return or file it electronically.

The standard edition of TaxACT is available as a free download at *www.taxact.com*. Electronic filing costs $7.95 per return, and downloadable state packages cost $12.95 for each of the 20 states supported. For an additional $9.95 you can download TaxACT Deluxe, which adds a feature that helps determine how life events such as marriage affect your taxes, a tax advisor feature, and a guarantee that 2nd Story Software will pay IRS penalties incurred if TaxACT makes a calculation error.

If TaxACT seriously beefs up its tax and program guidance, adds import capabilities, and broadens the scope of its preparation tools to allow more complex scenarios, TaxCut and TurboTax will have a fight on their hands next year.—***KY***

TaxACT. Prices: Free download; CD-ROM, $7.95 direct; TaxACT Deluxe, $9.95; $7.95 per e-filed return; each state edition, $12.95 download. Requires: 8MB RAM, 20MB hard disk space, Windows 95, 98, or NT. 2nd Story Software, Marion, IA; 800-573-4287; www.taxact.com; *415 at www.pcmag.com/infolink.*



A GREAT START: *In its first year, TaxACT features a clean look and a respectable set of tax prep features.*

return was submitted to the IRS.

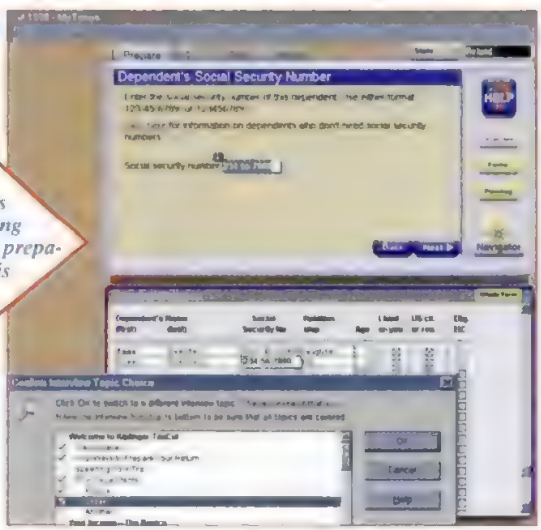
The IRS doesn't yet offer its own online vehicle for preparing and e-filing returns. At its main site, printable forms, schedules, publications, and IRS instructions are available, in addition to news and other information related to the IRS.

KIPLINGER TAXCUT

The program's look this year is practically spartan, but Kiplinger TaxCut hasn't lost any of its punch. Block Financial Corp. releases only estimated street prices for its products ($20 and $40 for the Basic and Deluxe products, and $70 for the Business edition), so you may be able to find them at prices similar to those of TurboTax.

The program offers the same data entry options as TurboTax, though its Fast Lane (similar to TurboTax's Fast Track) is broken out as an alternative. Significant changes, though, are few and far between in the 1998 version. Block has focused more on the core of the program, making its Q&A speedier and more effective.

TaxCut's working screens display the interview's questions and answer field at the top, with the active field displayed below. Unlike TurboTax, TaxCut makes you open the interactive list of tax topics (Navigator) to see where you are or to move elsewhere if you want to jump out of sequence.



PRIME CUT: *TaxCut keeps things simple this year, while still providing good navigational and preparation tools, such as this interactive topics list.*

TaxCut provides more information about topics than its competitor, though, marking each as Not Needed, To Do, In Progress, or Done. But its Navigator does not break out the topic list as thoroughly and doesn't make help and guidance as readily accessible as TurboTax does. And in some places, data entry requires more screens and mouse clicks.

Review tools and help resources compete well with those of TurboTax, though in general we'd give the nod to TurboTax for depth and usability in these areas. TaxCut's help button opens a tabbed folder containing several different kinds of assistance, ranging from Kiplinger tax tips to IRS instructions to a tax FAQ. You also get special aid within the interview itself, on such slippery topics as the Roth IRA. Tax preparation and filing are available on the Web site, but only to 1040EZ filers.

Kiplinger TaxCut. Street prices: TaxCut Basic, $20; TaxCut Deluxe Multimedia (includes all state editions), $40; TaxCut for Your Business, $70; All-State Edition CD-ROM, $25 (any state available direct for $25); one e-filed return, free. Requires: 8MB RAM; 20MB hard disk space; Windows 3.1, 95, 98, or Windows for Workgroups. Block Financial Corp., Kansas City, MO; 800-656-5426; www.taxcut.com; *413 at www.pcmag.com/infolink.*

PC MAGAZINE EDITORS' HOT LINKS

www.pcmag.com/hotlinks

Join us for an online version of this story; you can click directly to the following sites.

OneTax.com
www.onetax.com
This site offers 1040 and many related forms and schedules (but no critical documents, such as those required for supplemental income/loss). You can print and/or e-file federal and state forms for $9.95.

SecureTax.com
www.securetax.com
At this site, you get all major forms and schedules for forms-based entry (some wizards are available). You can print or e-file forms: The 1040EZ and state are $9.95; the 1040/1040A federal and state are $14.95.

TaxCut 1040EZ Online
www.taxcut.com
This site offers interview and forms entry for 1040EZ only. Printing or e-filing the form is free.

WebTurboTax
www.webturbotax.com
You get many of the same services as in TurboTax; printing or e-filing the 1040EZ is $9.95; the 1040/1040A costs $19.95. Filers with an adjusted gross income of $20,000 or less get free preparation and filing.

Tax and Accounting Sites Directory
http://taxsites.com
This site provides helpful links to government, commercial, and academic sites related to taxes.

TURBOTAX

This software comes in several configurations for the 1998 tax year: TurboTax ($17 street); TurboTax Deluxe ($27), which includes such extras as videos, IRS publications, a tax Q&A, and *Money Magazine*'s *Income Tax Handbook*; and TurboTax Home & Business ($70), which gives you everything in the other versions, plus extra support for business filers (especially helpful for those with at-home businesses).

Intuit has simplified navigation again this year with several new tools. Interview questions sit at the top of the screen, and the active form resides at the bottom.

The Interview Navigator, a list of the topics covered in your tax return (income, deductions, and so on), runs down the left. It expands horizontally when you run the cursor over it, and the list of topics builds as you move through the return and complete sections. Clicking on an entry takes you to that section.

Other time-savers include the Smart Interview system, which has been streamlined so entries (such as the list of your dependents) that previously took multiple screens to complete can now be polished off in one. And TurboTax integrates the Fast Track approach to data entry: Smart Interview asks questions that size up your situation and take you through pertinent sections only.

One of the smartest changes in TurboTax is the new context-sensitive FAQ feature. As in previous versions, the help button opens a multitabbed dialog box that lets you select from the help documents offered in your version. In addition, though, interview screens now post FAQ links that pertain to the active topic. Click on a question and an answer box pops up.

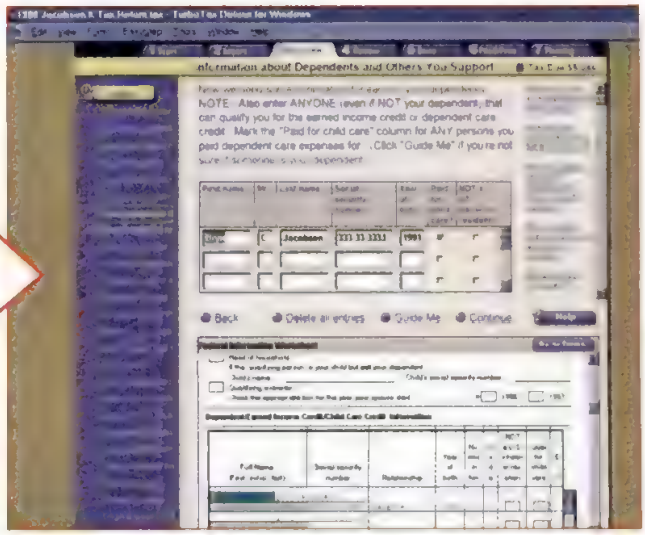
TurboTax 98's audit and review section is much the same as it was last year. When you've completed your return, the program runs several kinds of accuracy checks on it and reports on errors and omissions, possible missed deductions, and potential audit flags. It also compares

the major numbers in your return to U.S. averages and prepares a report of tax-saving options for the coming year. And now, in addition to running what-if scenarios on your return to help plan for next year, you can plug numbers into the new IRA Planner, which helps you determine your eligibility for a Roth IRA.

For $9.95 to $19.95 (depending on your return's complexity), you can prepare and e-file your return using WebTurboTax, the online version of TurboTax (same program and features, minus some of the help). Households with annual incomes of $20,000 or less can use WebTurboTax to file their returns free of charge (*www.webturbotax.com*).

TurboTax. Street prices: TurboTax, $17; TurboTax Deluxe, $27; TurboTax Home & Business, $70; State editions, $30; e-filing, $9.95 to $19.95. Requires: 8MB RAM; 25MB hard disk space; Windows 3.1, 95, 98, or NT 4.0. Intuit Inc., San Diego; 800-446-8848; www.turbotax.com; *414 at www.pcmag.com.*

ONE STEP AHEAD: *TurboTax is a winner, with new features such as context-sensitive FAQs, a streamlined interview feature, and an expandable navigational tool.*



OUR PICK

If you're currently doing your own taxes, there's no reason not to try tax software. Block Financial Corp. and Intuit call on the services of legions of tax professionals in preparing their products, and their expertise is yours for roughly 50 bucks. Both companies will pay any penalties you incur should their programs make a calculation error (but that's highly unlikely). You might want to consider these programs if your taxes are usually professionally prepared, but be careful: Some tax situations are very complex and need an accountant's hand.

Once again, we recommend TurboTax. Depending on the vagaries of retail pricing, prices of the two products could be very close. And Intuit's TurboTax is a step ahead of its competitor on all counts, particularly with this year's integration of Fast Track and context-sensitive FAQs. PC

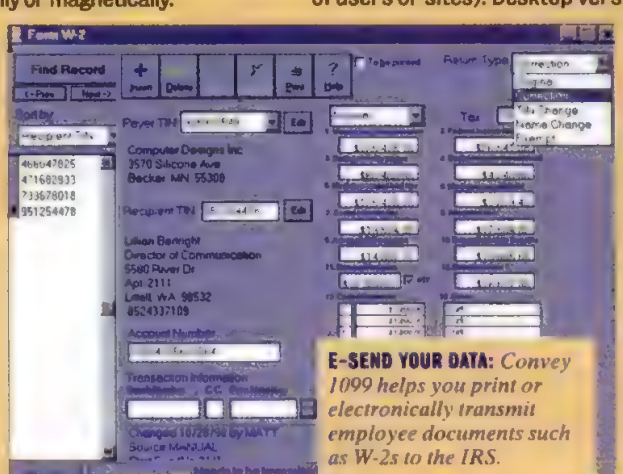
Conveying Employee Data Electronically

Taxpaying individuals aren't the only ones affected by the government's push towards collecting tax information electronically. Businesses, too, are being encouraged to modernize their methods. Convey 1099, a Windows product that's been around since its DOS beginnings in 1986, helps companies produce the W-2s and 1099s that must flow from businesses to employees and to the IRS. Large companies might want such a product because of the sheer volume of tax documents they must produce, but there's another compelling reason: The IRS currently requires any company that generates more than 250 W-2s or 1099s to do so electronically or magnetically.

Convey 1099, the desktop version, supports 1098, 1099, 5498, and W-2 forms. It costs $500 to $2,500 initially, then approximately 70 percent of that price for annual updates. Convey 1099 Client Server is designed for use in a networked PC environment. Both products offer similar functionality: You can import data in several common formats, including ASCII, dBase, and ODBC, using the program's mapping tools to get the information in shape. Convey 1099 transmits your data electronically or magnetically to the IRS, in files built to IRS specifications. You can print the forms on plain paper or on preprinted IRS forms.

Multilevel security is available in the network version, and both versions generate customizable reports and process corrections simply. Convey 1099 is easy enough to use, though the interface looks dated. It's a good solution for companies that must process and report tax-related employee information to the IRS.— *KY*

Convey 1099. Direct price (depending on volume and number of users or sites): Desktop version, $500 to $2,500; client/server version, $30,000 to $80,000. Requires: For desktop version, 8MB RAM, 20MB hard disk space, Windows 3.1, 95, 98, or NT; for client/server version, server requires 64MB RAM, 1MB hard disk space per 1,000 returns dedicated, Window NT; client requires 16MB RAM, Windows 95 or NT. Convey Development Inc., Minneapolis; 800-334-1099; www.convey1099.com; *416 at www.pcmag.com/infolink.*



E-SEND YOUR DATA: *Convey 1099 helps you print or electronically transmit employee documents such as W-2s to the IRS.*

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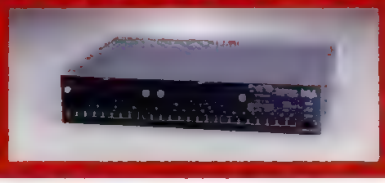

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One Size Stores All

Iomega's 40MB Clik! Drive connects to PCs, notebooks, Windows CE H/PCs, and digital cameras.

By Bruce Brown

The long-awaited Iomega Clik! Drive has finally arrived. Using 40MB removable disks, the Clik! Drive is available in a variety of configurations. It may take some time to get used to all the bits and pieces included with the Clik! kits, but relatively inexpensive storage (as little as $10 per 40MB disk), mobility, and connection flexibility make Clik! a removable storage winner.

The 40MB Clik! disks are rated at 700-Kbps average sustained transfer rate, with an average seek time under 25 ms and spin at 2,941 rpm. The tiny disks (one of which is included with each drive) weigh less than a half an ounce and measure .08 by 2 by 2.2 inches (HWD). Additional disks sell for $30 for two, $50 for three, and $100 for ten (all street prices). Each Clik! disk comes in a protective plastic case and, although the drive and disks are portable, each disk must be transported in a case, not in a drive, to protect both the media and the drive.

The Clik! Mobile Drive ($200 street) includes the 0.6- by 2.8- by 4.6-inch (HWD) drive, a Type II PC card with separate interface cable, a nickel hydride rechargeable battery, the Desktop Docking station/battery charger, a combination parallel-port interface/power cable, a Clik! disk, installation software, and a carrying case.

ALL-INCLUSIVE: *Accessories in the Clik! Drive Plus package include (clockwise from top left) the Clik! parallel-port interface, the Desktop Dock, the Flash Memory Reader, and the battery.*

DIGITAL CAMERA STORAGE

The Clik! Drive for Digital Cameras ($250 street) swaps the Mobile version's PC card and cable for photo-printing software and a flash card reader with slots to read CompactFlash and Smart Media memory cards. The tested Clik! Drive Plus ($300 street) includes everything in the other two bundles.

You don't have to run the Clik! drive on its battery power, but you should keep the battery attached to the drive, otherwise the exposed metal contacts could cause damage to the drive. The battery recharges in 1.5 hours and is rated for 30 minutes of continuous data transfer.

Clik! disks aren't meant to compete with hard disks or with classic Zip disks. Rather, they're a less expensive alternative to pricey CompactFlash memory, whose costs vary widely but are at least 10 to 15 times more per MB.

You can hook up the Clik! Drive to a PC parallel port, just like a Zip Drive (but you can't daisy-chain Zip and Clik! Drives on the same port). This establishes a transfer path to use after data is stored on a Clik! disk from another source.

You can use the Clik!'s PC Card interface to attach to your laptop. During installation, the PC Card is recognized as a standard ESDI/IDE drive controller. With either parallel or PC Card connections, the Clik! Drive is visible in My Computer and via Windows Explorer as a standard removable media drive.

WORKING WITH WINDOWS CE

The Clik! Drive ships with software for Windows CE devices (we tested it on a Windows CE 2.0 device). After installing the software, you can slide the Clik!'s PC Card into a Windows CE H/PC and view the Drive as a storage card.

Transferring files between a PC and a CE device is much quicker via a Clik! Drive than it is with a standard serial cable connection. At the time of our review, Clik! CE software did not work with the latest devices running Windows CE 2.2 (H/PC Pro), but Iomega is working on the driver software.

MINI-STORAGE: *The Clik! Drive and 40MB disks offer low-cost portable storage.*

The Flash Memory Reader, which ships with the Digital Camera and Plus bundles, is a plastic module that clips on the bottom of the Drive. It has separate slots for CompactFlash and SmartMedia cards—the two most common digital camera image-storage standards.

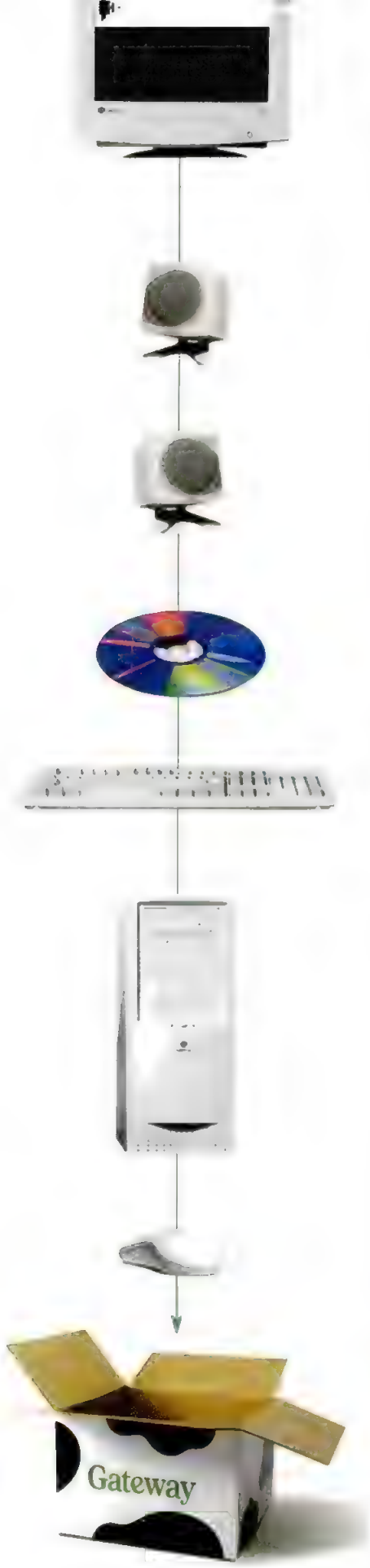
To transfer files from flash media to a Clik! disk, simply insert a piece of media into the Flash Memory Reader, push a button on the reader, and watch the LCD screen track the transfer process and report the percentage completed. (Note that the Flash Memory Reader is only for one-way data transfers to Clik! disks.)

You can only use the Flash Reader when the Clik! Drive is running on battery power. If you carry the Clik! Drive (with battery and Flash Memory Reader attached) with your digital camera, you can pause whenever you fill a SmartMedia or CompactFlash memory card to upload the images to the Clik! disk and free up space on the flash media.

The greatest advantage of the Clik! Drive is versatility: It lets you connect to and transfer information quickly and easily from desktop PCs, notebooks, Windows CE devices, and digital camera media. Add the Clik!'s portability and relative low cost and you have a great new device to add to your information-handling arsenal.

Iomega Clik! Drive Plus. Street price: $300. Requires: 16MB RAM; 25MB hard disk space; Microsoft Windows 95, 98, or NT 4.0. For Windows CE 1.0 or 2.0, 600KB RAM storage space. Iomega Corp., Roy, UT; 800-697-8833; www.iomega.com; *417 at www.pcmag.com/infolink.*

PHOTOGRAPHY BY THOM O'CONNOR



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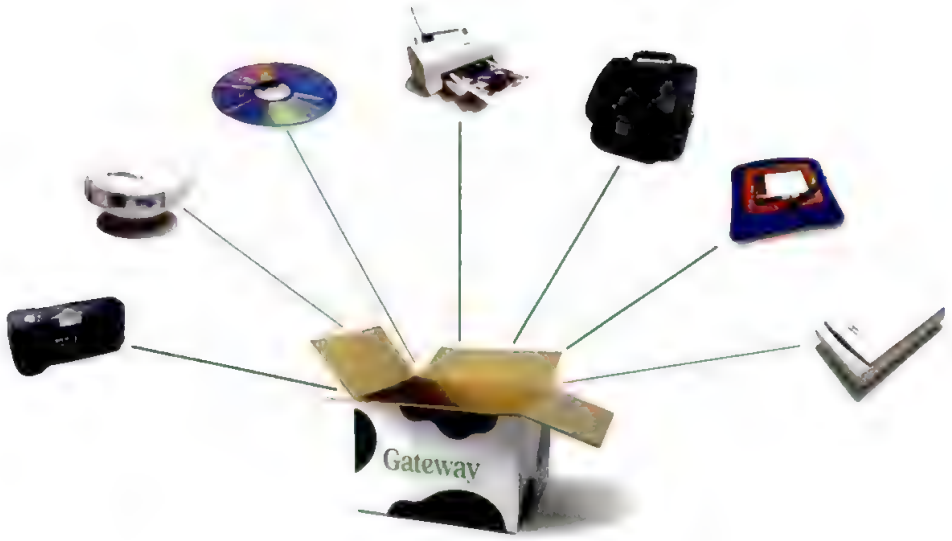

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Portable Handy Scan

The pocket-size HP CapShare 910 scans documents and sends them to your PC or printer.

By Alfred Poor

The new HP CapShare 910 is named for its two primary functions: capturing images and then sharing them. With a street price of $700, it's designed for the mobile professional who needs to deal electronically with paper documents.

The CapShare is deceptive in its simplicity. At 1.5 by 4.1 by 5.5 inches (HWD) and 12.5 ounces (including batteries), it adds little weight or bulk to your notebook case. Ten buttons on one side provide access to all of its features, and a 2.5-inch diagonal LCD lets you make menu selections and view the scanned images. The device's 4MB of memory is enough to store up to 50 scanned images.

The unit can scan about a 4.7-inch wide swath, and you scan a page in a single U-shaped pass: down the left side, across the bottom, then back up the right. The device automatically stitches the parts together to make a single image. The images are one-bit black and white; the unit cannot capture grayscale or continuous-tone images, such as photographs.

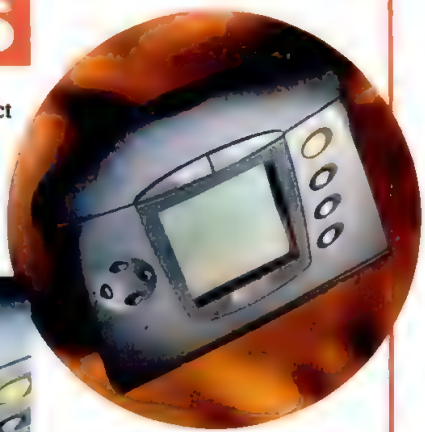
The share function comes in when you send one or more captured pages to a computer, either via serial or infrared connection. With infrared, you merely have to point the device at your computer's IR receiver and press a button. (We sent a page from *PC Magazine* in about 24 seconds.) You can also send pages directly to supported printers with infrared ports.

Files are stored on your PC as PDF files, though a pending software revision will also offer a TIFF option (for use with word processing or OCR programs). Attaching documents to e-mail messages or sending with fax software is relatively easy.

The CapShare is powered by two double-A penlight batteries. The package includes two pairs of rechargeable batteries, plus a recharging unit.

On our tests, we found it was difficult to scan reliably at the top of a page or within about a quarter of an inch along the edge of bound pages. On the other hand, the CapShare was very forgiving of imperfect scan movements.

All the HP CapShare 910 does is capture images from paper and send them quickly to your PC or printer, but it does so easily and reliably. If you find yourself on the road, wishing for an easier way to fax or e-mail documents back to the office, the HP CapShare 910 may provide the solution.



FAST IR: *Use the HP CapShare's IR interface to download documents.*

HP CapShare 910. Street price: $700. Hewlett-Packard Co., Palo Alto, CA; 877-473-6772; www.capshare.hp.com; *411 at www.pcmag.com/infolink.*

Better Billing Software

Sage's Timeslips Version 9, the time-tracking and billing software, has a new interface and more.

By Barry Simon

Many businesses have to track the time of professionals—notably lawyers, accountants and computer consultants—on a client-by-client basis. The standard program for small and medium-size businesses has long been Sage's Timeslips, and Version 9 is a significant upgrade.

LEAD ON: *The Navigator provides flow charts that guide you through involved tasks.*

In this 32-bit version of Timeslips, the database has been shifted from a proprietary format to the more robust Paradox engine. Timeslips will upgrade existing databases to the new format, although macros and scripts will not convert.

The program comes in three levels. Level 1 ($179.95 list) has basic time tracking and billing, with support for 2 *timekeepers* (computer codes that can enter slips for a time and billing event) and 5,000 clients. Level 2 ($399.95 list) adds Practice Management reporting and increases capacity to 8 timekeepers and 15,000 clients. Level 3 ($999.95 list) adds multiple-client funds accounting and fee allocation and ups capacities to 100 timekeepers and 30,000 clients.

The program supports multiple users over a network. You'll normally want each timekeeper on a separate workstation; each costs $50. There is also an extra-cost version (Timeslips Remote, $129.95 list) that can run on laptops and update the central database via dial-up.

In addition to such standard UI devices as context menus and multitabbed dialogs, Timeslips' unique Navigators provide flowcharts of the elements of basic tasks. The product ships with one Navigator, but you can also build your own. In fact, Timeslips has a notable ability to customize almost all aspects of the time-tracking operation.

Timeslips has been a leader in third-party electronic-bill delivery; it currently supports the services DATA Clearinghouse, Examen, Legal Billing Format, and Legalgard. Timeslips Accounting Link (TAL), a former add-on, is now included and allows export of accounts receivable data to over 30 accounting programs.

New features include the ability to allocate fees to multiple accounts and a redesigned WYSIWYG report writer with templates for mailing labels and graphs. A program called Station Administrator is included to monitor usage. A proprietary language lets administrators and power users automate some procedures and drive choices in the Navigator. We were disappointed that a standard macro language like VBA wasn't used.

Timeslips Version 9 is a must for current owners. This powerful upgrade keeps the program in the lead as a choice for small and medium firms.

Timeslips Version 9. List price: $179.95 to $999.95 (according to Level). Requires: 24MB RAM (32MB for NT); 50MB hard disk space; Windows 95, 98, or NT 4.0. Sage U.S. Inc., Dallas; 800-285-0999; www.timeslips.com; *412 at www.pcmag.com/infolink.*

PHOTOGRAPHY BY THOM O'CONNOR

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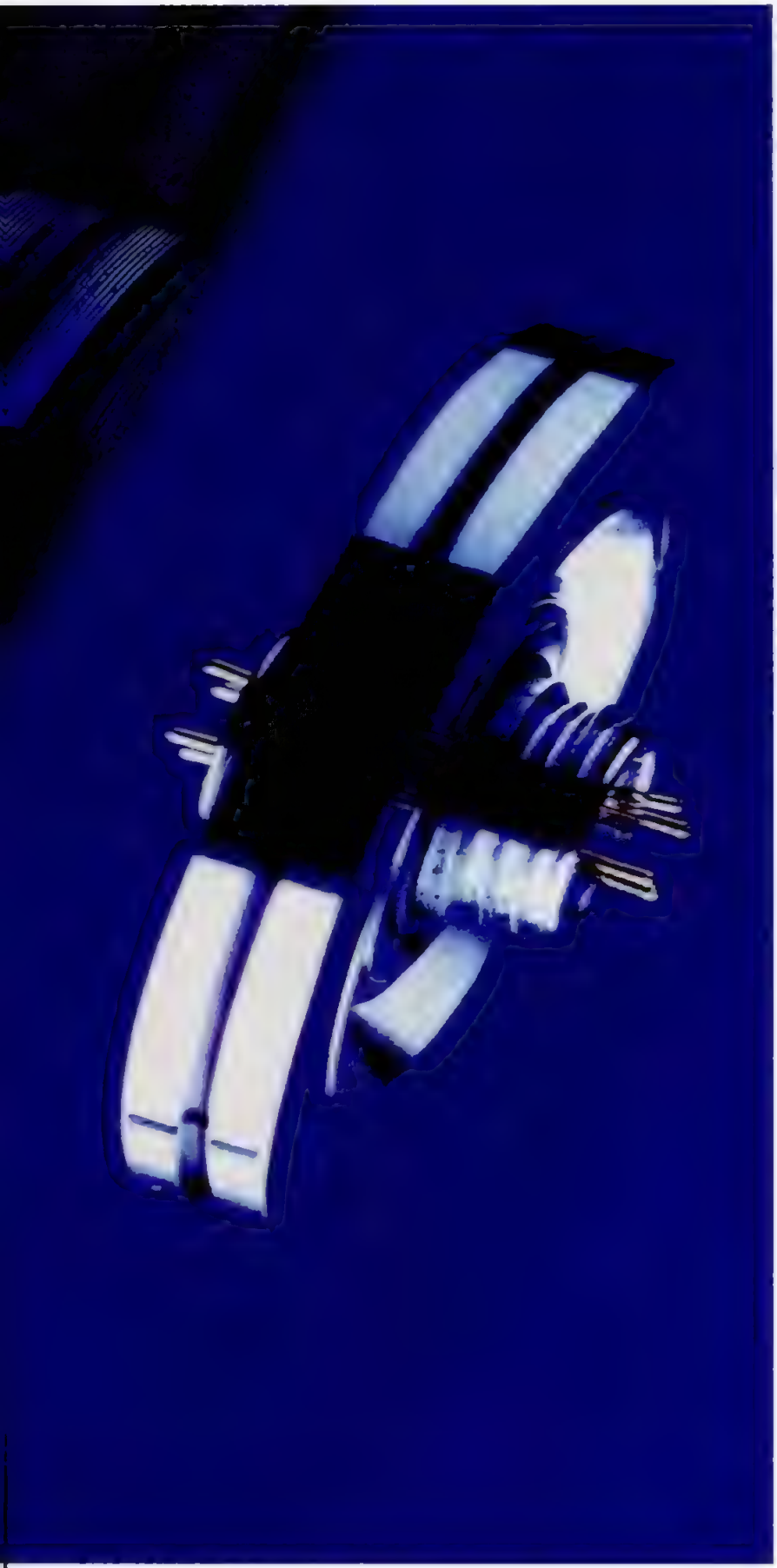

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What makes the stars twinkle?

How does the Internet work?

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Get Your Couch Back

The Harman Kardon Take Control TC1000 replaces myriad IR remote controls.

By Bruce Brown

Are you suffering from remote-control glut? Harman Kardon and Microsoft have codeveloped the Harman Kardon Take Control TC1000 ($349 list), which frees up your sprawling space and simplifies home entertainment command.

You can program the TC1000 to operate up to 15 devices. The 13.2-ounce controller (with four double-A batteries) measures 7.5 by 3.4 by 1.8 inches (HWD)—a bit large for small hands. The unit's 2.6- by 2.1-inch backlit LCD touch screen can be relatively hard to read—even after adjusting the contrast settings. The 120-kHz infrared transmitter has a range of about 23 feet.

Configuring the TC1000 is quick and easy; you can program most devices without running the bundled PC software. The controller is preprogrammed with codes for several hundred devices. If you are using a working remote for a device that's not preprogrammed, the controller often can learn the controls from the remote via infrared. If you don't have a working remote for a nonrecognized device, you're out of luck.

MULTIFUNCTION: *The TC1000 can operate up to 15 devices.*

In testing, the TC1000 quickly recognized a Sony TV, VCR, and laserdisk player and a Harman Kardon receiver. Training the device to control a DVD player in a Tiger Direct PC Cinema required running the Take Control Editor PC software, with the TC1000 connected via serial cable, plus using the PC Cinema's remote control to teach the TC1000. We configured the device successfully, but doing so took a little over an hour.

You can also train the TC1000 to recognize simple activities, such as "Watch TV," which in the test setup entailed turning on the TV, selecting the channel on the VCR, and controlling the audio via the stereo receiver. Activities can be configured with the remote alone or in conjunction with the Take Control Editor.

Using the Editor you can also set up more complex macros, combining buttons and actions from a variety of devices. For example, you can create macros to tape your favorite daily program with menus for individual family members.

Though its screen is a bit dim, the Harmon Kardon Take Control TC1000 can replace your coffee table's confusing mess of remote controls with one easy-to-use (albeit expensive) device.

Harman Kardon Take Control TC1000. List price: $349. Requires: 8MB RAM; 2MB hard disk space; Microsoft Windows 95, 98, or NT 4.0 or later. Harman Kardon, Woodbury, NY; 800-645-7484, 516-496-3400; www.harmankardon.com; *410 at www.pcmag.com/infolink.*

Back It Up—with Tape

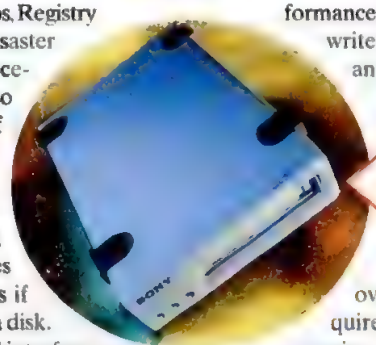
The Sony SuperStation tape drive backs up today's enormous hard disks in one pass.

By Alfred Poor

Perhaps the only thing more amazing than the low cost of 6GB to 10GB hard disks is the speed with which these huge disks fill up with programs and data. But how can you best safeguard all that information? Most removable disks can't cut it; you need more than 60 Zip disks to back up one 6GB disk. For storing this much data in a single pass, take a look at the new Sony SuperStation tape drive.

The drive comes in two models. The internal version ($150 list) uses an EIDE/ATAPI interface. We tested the external version ($180 list), which connects to a parallel port. The drive was easy to connect and configure, and we were ready to run in under 2 minutes. Windows recognized the SuperStation immediately.

The SuperStation comes with Seagate Backup Executive, a powerful, flexible program that provides scheduled and incremental backups, Registry backup, and disaster recovery procedures. You also get a copy of Seagate Direct Tape Access, which lets you read and write files on the tape as if they were on a disk.



ROOM TO GROW: *The Sony SuperStation lets you store up to 10GB on one disk.*

The parallel interface was not as fast as we'd expect an EIDE connection to be. The SuperStation is rated at up to 50MB per minute for data transfer, but our tests produced considerably slower results, probably at least in part because of the parallel-port connection. Using data compression, our test data set averaged a 1.89:1 compression ratio, and the SuperStation wrote 15.5MB per minute. Without compression, the performance was proportionately slower, at 8.4MB per minute.

These results indicate that performance is limited by write speed, and any processing overhead required by compression does not have a significant impact on performance. So even using compression, backing up 8GB of data from a hard disk would take more than 8.5 hours. Also, Seagate Backup Executive offers a verify pass after writing; this roughly doubled our test times.

Seagate Direct Tape Access worked well, though it's not a substitute for a random-access device. It wrote data at a 12.3MB-per-minute rate on our tests.

The SuperStation can use tapes of either 6.6GB or 10GB capacity. Tapes are rated based on their estimated capacities using compression, assuming a 2:1 compression ratio. A 6.6GB tape retails for $25, and a 10GB tape retails for $35—which comes to a little more than a third of a cent per megabyte.

Given its low cost and enormous capacity, the SuperStation is a leading choice for full backups of high-capacity hard disks. Keep in mind that a full backup will require an overnight run—but you'll get the job done.

Sony SuperStation. List price: $180. Sony Electronics Inc., Park Ridge, NJ; 800-352-7669; www.sony.com/storagebysony; *409 at www.pcmag.com/infolink.*

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(PC Sold Separately)

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Today, regardless of the PC brand you choose, the most important component is not the computer. It's the monitor. Yesterday the hot phrase was "Monitor Sold Separately." Today, it's "PC Sold Separately." Technology blurs the lines between one computer and another. They're all fast, all loaded, all pretty much the same.

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Affordable Celeron Notebooks Deliver

Intel's supposed "entry-level" processor still provides competitive processing punch in two value notebooks from HP and Toshiba.

By Asa Somers

Whether you're purchasing a single notebook for your own small business or outfitting a mobile fleet, dropping well over $2,000 on each new laptop has got to hurt. But you and your staff need certain features, which drives the price into the stratosphere, right? Call it the bell-and-whistle effect: It always seems the mobile computer you want, with the options and power you require, will cost you at least $2,500.

Not so fast. The processor wars have finally hit the mobile space, and thanks to so-called entry-level CPUs like Intel's Celeron, a fast, tricked-out notebook won't necessarily cost you a king's ransom. We looked at two such boxes—the HP OmniBook XE and the Toshiba Satellite 4030CDT; both feature a Celeron processor and carry a price tag of $2,000 or less.

TOSHIBA SATELLITE 4030CDT

The most impressive thing about these machines is that the Celeron processor won't cost you a hit in performance. The Toshiba Satellite 4030CDT ($2,000 street), with its 300-MHz Celeron CPU, is a case in point.

On our Business Winstone 99 benchmark test, the Satellite's score of 13.7 was right in line with the average 300-MHz PII notebook's score of 14.6. It also lasted longer on our BatteryMark 2.0 test, staying alive for 2 hours 51 minutes. These are interesting numbers indeed when you're about to save around 500 smackers on a similarly configured Pentium II notebook.

FULL-FEATURED: *The 300-MHz Celeron–based Satellite features 64MB of RAM, a 24X CD-ROM, and a 13.3-inch display.*

Speaking of configuration... you'll see that's where the Satellite really shines. First of all, this 6.7-pound baby is a three-spindle device, so you won't ever be swapping devices in and out.

The sleek gray case opens to reveal a crystal-clear 13.3-inch LCD, which in testing provided rich corner-to-corner color and acceptable off-axis viewing. Moreover, though the screen can handle XGA resolution at 64,000 colors, presentation jockeys can drive external displays at 1,280-by-1,024 resolution directly from the Satellite's VGA port.

We were even impressed with the Satellite's keyboard, which always seems to be one of the first things to go when the manufacturer is trying to keep a system's price down. Like a good mattress, the 84-key keyboard was refreshingly firm (not too springy). We did have trouble getting a sticky Spacebar to function properly, but in the end it worked fine.

Okay, so it's a pet peeve of ours, but we do wish the Backspace key weren't placed *inside* the Home key, where it can cause problems. Also, the arrow keys should be set apart from the rest to make them more easily accessible. The Satellite's pointing stick and contoured actuation buttons, mounted in the comfortable and wide wrist rest, made for acceptable cursor control.

There are plenty of other gimcracks and gewgaws to keep the peanut gallery happy: The Satellite features 64MB of RAM, a 4.1GB hard disk, a full complement of standard ports, CardBus-ready PC Card slots, a hardware volume control, and a fixed 24X CD-ROM drive. Its internal 56-Kbps modem worked flawlessly in testing.

We recommend the Toshiba engineers rethink the removable rubber cover on the expansion port, which will inevitably get lost. If you need to expand your notebook on the desktop, there are three different port-replication solutions available for the Satellite.

Operational hazard: Watch out if you pop an audio CD into the Satellite's tray. This machine's 3D Sound–capable audio subsystem and Stereo Bass Reflex Speakers are about as powerful and clear as any we've evaluated. You can easily turn the volume up *way* too loud for any conference room.

All in all, the Satellite represents quite a value for all types of mobile workers. It's a feature-packed notebook with good performance numbers that's bound to satisfy most users. The hard-core corporate set may demand more flexibility, serious number-crunching power, or high-end multimedia capabilities, but the Satellite is the notebook for the rest of us.

Toshiba Satellite 4030CDT. Street price: $2,000. Toshiba America

PERFORMANCE TESTS

Celeron Notebooks

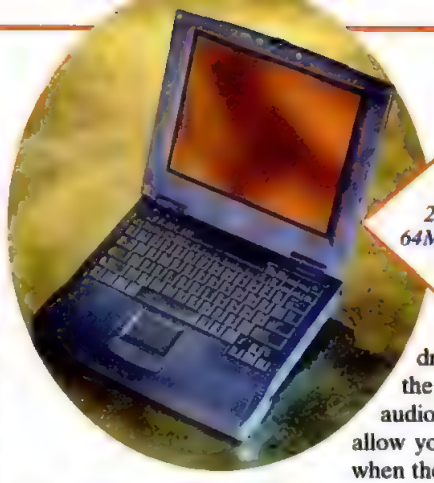
We were impressed by the performance of these Celeron notebooks, particularly on our Winstone tests: Their average score was less than 5 percent behind similarly equipped 300-MHz Pentium II portables units we've tested previously. Battery life was also great, as both outlasted the average Pentium II/300 by a healthy margin. Both systems prove that you don't have to break the bank to get a well-rounded notebook.

	ZD Business Winstone 99	ZD Business Graphics WinMark 99	ZD Business Disk WinMark 99	ZD BatteryMark 2.0	ZD CPUMark32
HP OmniBook XE (Celeron/266)*	14.1	73	1,590	2:39	568
Toshiba Satellite 4030CDT (Celeron/300)	13.7	52	1,590	2:51	654
Average Pentium II/300 notebook	14.6	N/A	N/A	2:10	745
	BETTER ▶	BETTER ▶	BETTER ▶	BETTER ▶	BETTER ▶

* Tested at 800-by-600 resolution N/A—Not applicable We did not run this test

PHOTOGRAPHY BY THOM O'CONNOR

Information Systems Inc., Irvine, CA; 800-867-4422; www.toshiba.com; *408 at www.pcmag.com/infolink.*



VALUE-ORIENTED: *The OmniBook features a 266-MHz Celeron CPU, 64MB of RAM, a 24X CD-ROM, and a 12.1-inch dual-scan display.*

HP OMNIBOOK XE

You'll have to cut some corners to go much below $2,000, and that's where the HP OmniBook XE series comes in. We looked at the baseline 266-MHz Celeron-based model, which serves as the entry point of this value/mid-range line. Our evaluation model, configured with 64MB of RAM (as opposed to the standard 32MB), will run you $1,600 (street).

The OmniBook's stand-out performance on our benchmark tests was largely due to the fact that we tested it at its native 800-by-600 resolution. This led to a Business Winstone score of 14.1, only a half a point behind the average Pentium II/300 notebook. On our BatteryMark test, the OmniBook lasted a very acceptable 2 hours 39 minutes, outpacing the PII/300 by 29 minutes.

Screen size and technology are the OmniBook's biggest shortcomings. The OmniBook provided only 12.1 diagonal inches of high-performance addressing (HPA) dual-scan display technology. Here's your cost savings, front and center. The display is very clearly passive-matrix, suffering from noticeable banding and ghosting and offering poor off-axis viewing. Moreover, it handles only a maximum SVGA resolution, which is probably a good thing, as XGA text and icons would be difficult to read on this screen.

There's still lots to like about the OmniBook, however. The 6.8-pound machine is another three-spindle device, featuring fixed floppy and 24X CD-ROM drives. We absolutely love the OmniBook's external audio CD controls, which allow you to play music even when the machine is powered-down. Located along the front side of the box, these controls include a power button that lights up when you've turned the drive on, as well as fast-forward, rewind, play/pause, stop, and volume buttons.

The machine's fancy-schmancy stereo speakers, mounted inside the wrist rest, occupy two internal cavities designed to use natural acoustics to boost bass response. Although the sound was awfully loud and clear, it was still a little tinny to our ears.

The OmniBook requires you make no real sacrifice on features, as it ships standard with a 4.1GB hard disk, an internal 56-Kbps V.90 modem, stacked Card-Bus- and ZV-enabled Type II PC Card slots, and all the requisite ports, including USB, which functioned perfectly in testing.

The only other area where the machine falls short is in its keyboard. A stark contrast to the Satellite's keyboard, this 87-key job felt much too spongy for our tastes. But it does feature a full-size Backspace key in the most advantageous position and arrow keys that are set apart from the rest of the keyboard.

This bottom-of-the-line Celeron-based HP OmniBook XE delivers an impressive punch for this price. Its target market—mobile fleets, value-conscious small businesses, and consumers—will find much to be satisfied with. And if you simply need a finer screen or more power or disk space, you can opt for a higher-end model in the same line, with prices ranging from $1,800 to $2,700.

HP OmniBook XE. Street price: $1,600. Hewlett-Packard Co., Palo Alto, CA; 800-322-4772; www.hp.com; *403 at www.pcmag.com/infolink.*

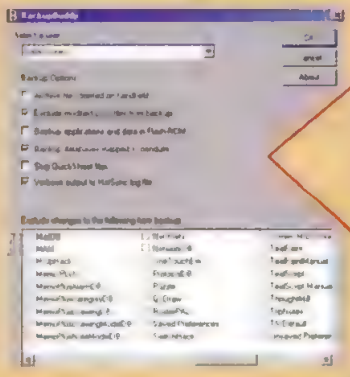
Portable Protection

True road warriors don't travel with notebook alone. For speedy access to contact and schedule information, a PDA is required equipment. And as you load up your PDA with more software to expand its functionality, the data and applications are increasingly jeopardized. 3Com's HotSync backs up data from bundled Palm applications but can't back up and restore data from third-party applications that don't provide their own conduits. BackupBuddyNG ($19.95 direct) comes to the rescue to ensure the safety of your data and applications.

Configuration Manager presents user options, including archiving files to your desktop computer, creating a detailed report to the HotSync log file, and excluding applications from the backup process to save HotSync time. There's also an option to back up all Palm files, including TRG FlashBuilder data files stored in Flash ROM.

BackupBuddyNG runs each time you run HotSync. The first time the program runs, it takes longer to create a complete backup directory than with subsequent backups, which take as long as a routine HotSync. Our initial backup took 17 minutes for 1.6MB of stored files in a Palm III.

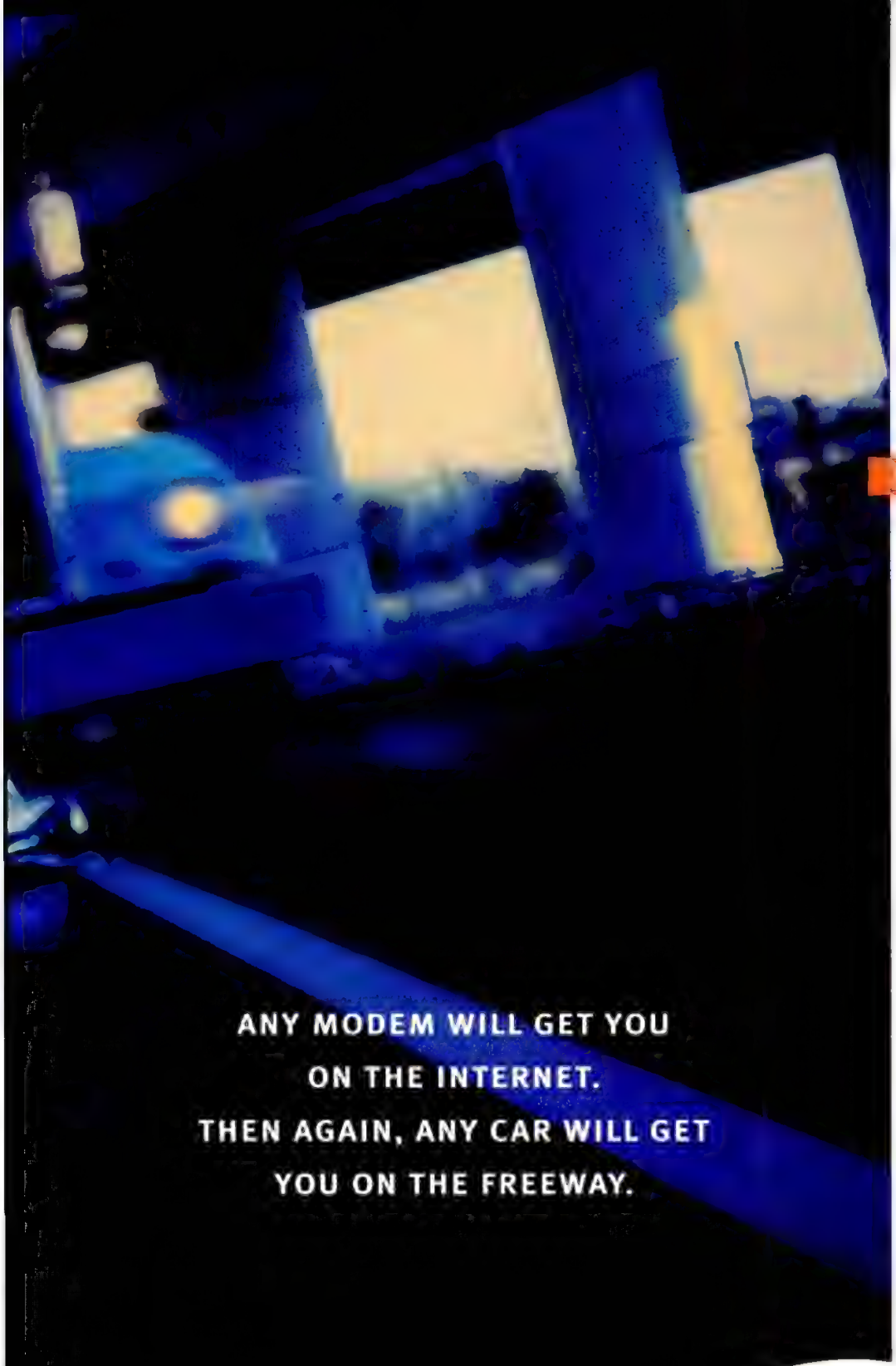
In the event of complete data loss, BackupBuddyNG can restore the contents of your Palm device by changing the HotSync customization screen to have the desktop files override the Palm files at the next HotSync. To restore a single application or file, you can locate the backup directory quickly by clicking on the Configuration Manager's "B" icon and then install the file via the Palm Install Tool.



BACK IT UP: *The BackupBuddyNG Configuration Manager lets you customize your backup process.*

Users who have ever lost Palm data can appreciate the value of BackupBuddyNG; it is an inexpensive yet powerful tool that works along with HotSync to safeguard all Palm files.

BackupBuddyNG. Direct price: $19.95. Requires: Microsoft Windows 95, 98, or NT 4.0; HotSync 3.0; IBM WorkPad PC Companion or 3Com PalmPilot Professional or Palm III or later. Intelligent Systems, San Francisco; 415-292-4493; www.backupbuddy.com; *405 at www.pcmag.com/infolink.*—*Bruce Brown*



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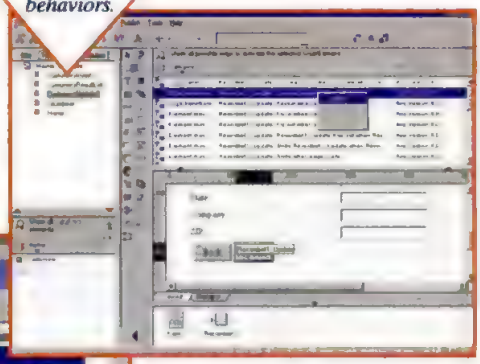
Robust Web-Site Builders

Drumbeat 2000 and NetObjects Fusion 4.0 are updates of the two most powerful site-builder packages.

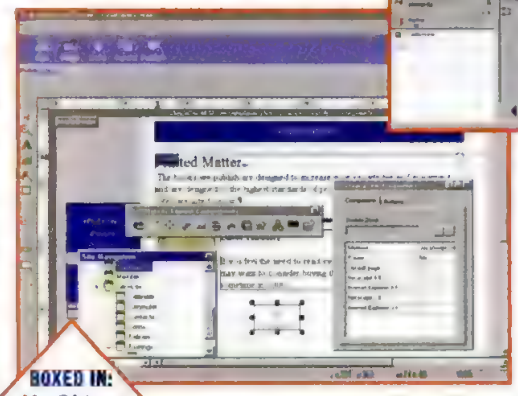
By Edward Mendelson

Web site–builder software helps you to create industrial-strength Web sites, complete with database access, in a WYSIWYG environment: You drag and drop page elements to an editing screen, and the software generates coded pages and uploads them to your server. Elemental Software's Drumbeat 2000 and NetObjects Fusion 4.0 are robust new versions of the two superior programs in this category.

Unlike traditional Web-page editors, both programs use proprietary formats during the editing process, generating HTML code only when you're ready to preview or publish your site. Drumbeat excels at database integration, and Fusion is best at graphics-intensive design.



IN STEP: *Drumbeat's complex but logical interface gives quick access to invisible page elements such as browser-specific behaviors.*



BOXED IN: *NetObjects Fusion's interface includes floating toolbars and pop-up windows; invisible page elements are displayed as boxes during editing.*

DRUMBEAT 2000

Drumbeat 2000 ($400 street) is the third version of a stunningly powerful package, built for creating Web sites with dynamic access to databases without requiring you to write a line of code. This isn't a tool for beginners—but if you understand the basic principles of databases and HTML forms, Drumbeat lets you build efficient, flexible, and unique Web sites with little effort.

After you answer a few questions in a wizard, Drumbeat builds Microsoft Active Server Pages that let visitors access and update your database. The database-driven features require Active Server Page capabilities, but if you don't use Drumbeat's database features, its HTML output can be used on any Windows or Unix server.

Unlike Fusion, Drumbeat has no automated tools for building navigation bars or changing sitewide styles. Instead, it uses a template-based architecture in which you modify the design of all or part of a site by editing one underlying page layout.

Drumbeat's interface works like a programmer's development environment. A customizable toolbar divides the editing window from a tabbed panel that displays site structure, a template hierarchy, and element attributes in the top half and lists of assets, styles, links, and dynamic HTML features at the bottom.

The editing window includes optional panels above and below for managing such invisible page elements as cookies, scripts, and the database whose content is accessible through the page. Unlike Fusion, Drumbeat makes all its controls separate and easily accessible.

Drumbeat doesn't build fancy graphics, but it does give expert users fast access to virtually every technology available on the Web, including ActiveX, JavaScript, and multimedia. If you're building a Web site with database access, nothing else even comes close.

Drumbeat 2000. Street price: $400. Requires: 32MB RAM, 30MB hard disk space, Microsoft Windows 95 or NT 4.0. Elemental Software, Carlsbad, CA; 877-378-6232; www.drumbeat.com; *400 at www.pcmag.com/infolink.*

NETOBJECTS FUSION 4.0

NetObjects Fusion was the first WYSIWYG site builder, and Version 4.0 ($299.95 list) benefits and suffers from the program's history. Benefits include 55 dazzling, mature graphics styles for buttons, borders, and other visual elements.

New features include table editing, Java-based drop-down navigation menus, and such JavaScript features as automatic redirection according to the browser used. But Fusion wasn't designed for the dynamic database connectivity features that the new version supports through awkwardly implemented add-on connections with Allaire Corp.'s ColdFusion, iCat Corp.'s Commerce Publisher, or Microsoft Active Server Pages.

The program's strength is still in graphics and layout. Each site has a customizable graphics style that can be changed or replaced with a few mouse clicks, and the changes propagate automatically throughout the site, though individual pages can have their own graphics styles.

Fusion's pixel-level control of text and graphics positioning appeals to traditional, paper-based graphic designers, but it can be a mixed blessing for Web design. For example, by default, the program places a text-only navigation bar in a fixed location at the foot of the page (in addition to a graphics-based bar on the left), so your site will look its best only if a visitor's browser is sized correctly.

You build pages in Fusion by clicking on a tool icon, then drawing a box on the page to contain a page element, which can be anything from a plain text box to a third-party JavaBean. Confusingly, you also draw boxes on the page to insert invisible elements such as JavaScript.

The most outdated feature of the interface is its inability to display multiple views of a site in separate windows. You have to switch through separate site, asset, style, and page views, although a pop-up window lets you navigate the structure of a site while editing. Worse, when you change a page title in the page editor, the page isn't renamed in the site view, making it almost impossible to find the page you want.

Fusion's main competition for ordinary Web-site building is Microsoft FrontPage, which is far faster and easier to work with but lacks Fusion's pixel-level graphics control. For graphics-rich Web sites without HTML coding, though, Fusion still surpasses all rivals.

NetObjects Fusion 4.0. List price: $299.95; upgrade, $99.95. Requires: 32MB RAM, 50MB hard disk space, Microsoft Windows 95 or NT 4.0. NetObjects Inc., Redwood City, CA; 650-482-3200; www.netobjects.com; *401 at www.pcmag.com/infolink.*

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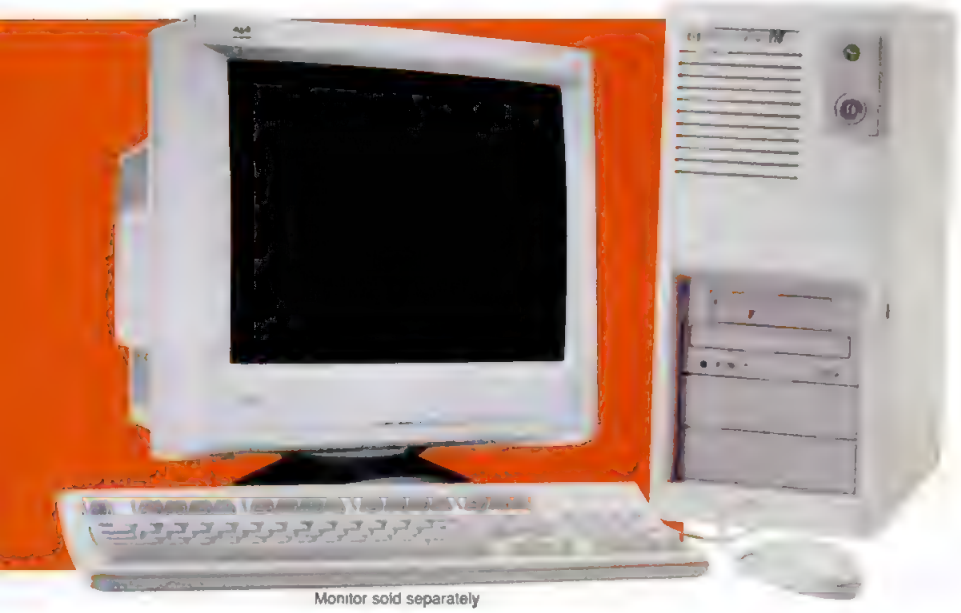

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Modular Megapixel

Minolta debuts an upgradable digital camera with interchangeable lenses for flexible photography.

By Daniel Grotta and Sally Wiener Grotta

The Minolta Dimâge EX 1500 ($900 street) is the first consumer digital camera that is upgradable and has interchangeable lens capability. It comes with a variety of useful features and functions designed for business users and semiprofessional photographers. What's more, image quality is the best we've seen in this class.

The Dimâge EX is available in two models ($900 each): The EX ZOOM 1500 has a 3:1 optical power zoom, and the EX WIDE 1500 has a high-speed (f1.9) wide-angle lens with a coverage equivalent to a 28-mm lens on a 35-mm camera. For an additional $500, you can have both lenses. Either lens unit can be detached and replaced with the other lens, a serial interface, or other to-be-announced peripherals.

The Dimâge EX uses Digita, FlashPoint's built-in OS, which makes setting up and shooting relatively easy and versatile. For instance, instead of one-size-fits-all exposure compensation, users can select pro-like half-stop and full-stop bracketing. The camera also features time-lapse photography, full- or quarter-frame size, two auto-focus settings, and auto-rotate.

Using the Dimâge EX is simple, as long as you respect its quirks. The motorized zoom lens is noisy, making candid shooting a problem. Not only does the lens extend so far that it clips a corner of the viewfinder in wide-angle mode, but the UV filter is flush with the bezel, making fingerprints on the lens unavoidable.

The optical viewfinder displays less coverage than the camera actually captures. The LCD viewfinder is grainy, jerky, and virtually impossible to see in bright light. In addition, we weren't able to check accurate focus in macro mode. Because the CompactFlash memory card is next to the batteries on the bottom of the camera, the batteries will fall out if you're not careful when you open the compartment.

There's practically no delay between pressing the shutter and capturing an image. The Dimâge EX's large 16MB buffer makes it possible to capture up to seven images in 2 seconds (sans flash, of course).

Where the Dimâge EX excels is in image quality. The camera has a resolution of 1,344 by 1,008 pixels; users can select from three compression levels plus an uncompressed JPEG that interpolates a raw 1.4MB file up to 3.8MB. Images are exceptionally crisp and sharp, with accurate and pleasing colors. Better yet, the dynamic range is superb—as good as some pro digital cameras—capturing details in dark shadows and bright highlights.

CHANGE IS GOOD: *The Dimâge EX accepts a zoom or wide-angle lens*

Versatility, simplicity, and excellent images, plus true interchangeable lenses, put the Dimâge EX at the top of its class.

Minolta Dimâge EX 1500. Street price: $900. Minolta Corp., Ramsey, NJ; 201-825-4000; www.minoltausa.com; *402 at www.pcmag.com/infolink.*

Pro Prints Come Home

The HP DeskJet 882C offers home users high-quality color output and versatile USB connection.

By Bruce Brown

For home business or personal use, the HP DeskJet 882C ($300 street), from Hewlett-Packard, is an affordable, high-quality color printer. With its incremental print speed improvements, USB support, and new handout and poster prints, the HP DeskJet 882C is a great replacement for the HP DeskJet 722C.

AT HOME: *The HP DeskJet 882C features fast yet high-quality color printing.*

At 7 by 17.8 by 13.8 inches (HWD), the HP DeskJet 882C retains the compact design of its predecessor. Setup and driver installation via either parallel port or USB connection takes under 15 minutes (cables not included).

Our test prints were of professional presentation quality. The 882C achieves vivid colors with HP's PhotoREt II color-layering and ColorSmart II optimization technologies. Up to 16 ink drops are placed in a single pixel to expand color intensity and shading without sacrificing print speed for resolution.

The 882C's useful formatting options include manual two-sided printing, printing up to 4 pages per sheet, and segmenting an image into 4, 9, or 16 pages for making posters.

The HP unit prints on a variety of media, from premium photo paper to transparencies, banners, greeting cards, and T-shirts. You can customize media size from 3 to 8.5 inches in width to 3 and 14 inches in length, and you can insert batches of 100 sheets at a time. The 882C's duty cycle is 2,000 pages per month, double the 722C's.

Depending on print mode, the HP DeskJet 882C is rated to print 0.5 to 1 more pages per minute (ppm) than the HP DeskJet 722C. The 882C's fastest rated speeds are 8 ppm for black text and 5 ppm for color.

The HP Printing Possibilities software bundle includes three photo and graphics applications: Mindscape's PrintMaster Gold Publishing Suite, Microsoft's Picture It! Express, and Professor Franklin's Instant Photo Effects, from Streetwise Software.

Two Web sites are worth investigating for use with the 882C: HP Instant Delivery (*www.instantdelivery.com*), for printing customized newspapers using content from such publications as *USA Today*, and the HP DeskJet site (*www.deskjet.com*), for fun printing projects.

Whether you need a durable, home-based, high-quality color printer for work, play, or both, the HP DeskJet 882C is capable of supporting broad usage. The unit is a versatile, fast, and affordable personal printer with a good balance of economical and creative features.

HP DeskJet 882C. Street price: $300. Requires: 8MB RAM (16MB for NT); 20MB hard disk space; Microsoft Windows 3.1*x*, 95, 98, or NT 4.0. Hewlett-Packard Co., Palo Alto, CA; 800-752-0900, 650-857-1501; www.hp.com; *403 at www.pcmag.com/infolink.*

PHOTOGRAPHY BY THOM O'CONNOR

*Estimated reseller price to end users for IBM PC 300GL model 6287-41U monitor shown is IBM G-54 with 15" screen and 13.7" viewable image starting at $239 certain features described below are available for an additional charge Actual prices may vary MHz denotes microprocessor internal clock speed only; other factors may also affect application performance. PCs in this ad include an operating system. IBM product names are trademarks of International Business Machines Corporation Wake on LAN is a product of IBM/Intel Advanced Manageability Alliance and is a trademark of IBM Corporation. Intel, the Intel Inside logo and Pentium are registered trademarks of Intel Corporation © 1999 IBM Corporation All rights reserved

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e-business tools

Diagrams for Pros

Actrix Technical and Visio Technical 5.0 Plus give you powerful yet easy-to-use functionality.

By Stephen W. Plain

For technical professionals, accurate diagrams are often the foremost means of communication. So the challenge for software vendors is to deliver a package that puts professional-level diagrams in the hands of the broadest audience while offering an extensible platform for sophisticated custom development. Autodesk's Actrix Technical and Visio Corp.'s Visio Technical 5.0 Plus (each $349 list) are excellent solutions for this demanding user base.

Although these programs are targeted chiefly at highly technical disciplines (such as engineering, manufacturing design, and facilities management), both cross over into mainstream business use with organizational charts, marketing symbols, and the like. Visio Technical is part of the company's family of drawing products. Actrix, the debut product of a new line for Autodesk, offers a similarly extensive set of symbols for roughly the same audience.

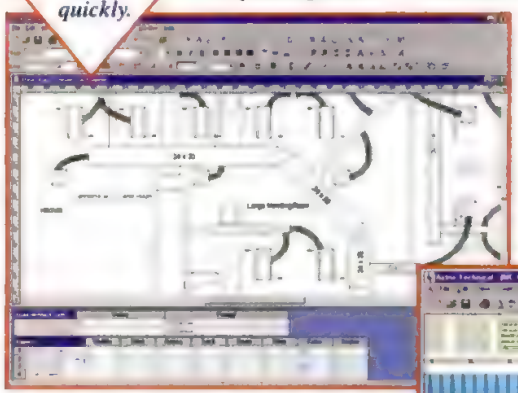
SMART SHAPES

In Actrix, many of the shapes seem to have an intelligent knowledge of their contexts, through Autodesk's Plugs and Sockets technology. For example, partition sections and duct work automatically guide themselves to connections to other appropriate shapes in a drawing. Visio Technical's connector objects also attach automatically, but we found Actrix's capabilities much more powerful.

Both products let you open collections of shapes specifically designed for particular types of drawings. In Visio Technical, these are called *Stencils;* in Actrix, they are referred to as *Catalogs.* You can keep open the Catalogs or Stencils that you need and drag and drop objects into your drawing from them.

The interfaces in both programs are flexible and mature. We found Actrix's dynamic zooming and panning feature especially useful. It let us zoom smoothly in and out and slide the drawing around quickly with the mouse, and it's compatible with the wheel on a Microsoft IntelliMouse.

GUIDANCE: *One of Visio Technical 5.0 Plus's strengths is its broad range of wizards, which guide you through the initial design phase quickly.*



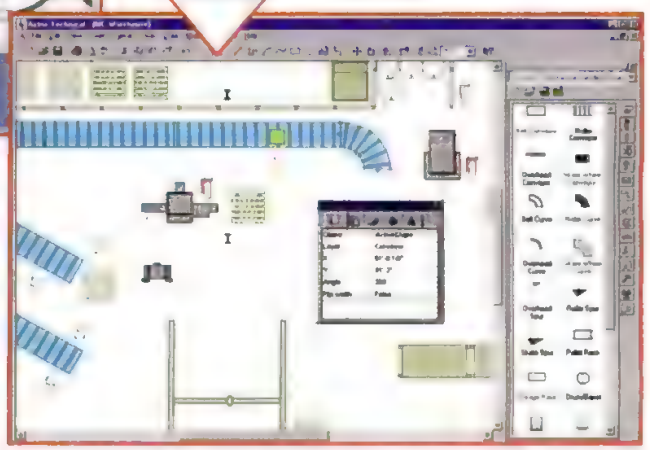
EDITING PROPERTIES

Both products let you modify the characteristics of each shape with properties and attach data fields to each object, to track information such as inventory and cost figures. In Actrix you do this with the Property Window—a tabbed formatting and data-field dialog similar to those found in visual programming environments. Visio Technical lets you modify properties for shapes and access them via custom dialogs. You can attach your own properties to objects in both programs; Actrix uses a more streamlined method of adding and editing custom properties.

Actrix is also stronger when it comes to editing shapes. By simply selecting Edit ActiveShape for any shape in your drawing, you can use the built-in graphical editor to modify the shape. You can even position Plugs and Sockets to define visually how the shape interacts with others.

Actrix enjoys an edge in precision drawing, but Visio Technical features a number of built-in wizards that offer a high-level helping hand for several tasks, such as laying out floor plans, performing space analysis, and designing organization charts. New to this version of Visio Technical is the ability to display drawings done with AutoCAD Release 10 and Release 12 as backgrounds to your diagrams, as well as the ability to convert AutoCAD objects to Visio SmartShapes. Not surprisingly, however, the Autodesk product has the edge here too. It adds the capability of aligning and snapping its shapes to the geometry of an associated AutoCAD drawing.

EASE OF USE: *Actrix's Property Window, innovative Plugs and Sockets, and friendly interface take technical drawing to a new level of usability.*



A VBA BASE

Visual Basic for Applications (VBA) forms the programmatic foundation for both of these products. If you need to automate the behavior of any object or drawing, you can write VBA code with the integrated VBA Editor.

The inclusion of VBA also gives casual users the ability to modify object behavior, with simple expressions that rely on VBA under the covers to do their magic. VBA gives these products an engine for developing specialty vertical-market solutions or enterprise-wide custom configurations.

The two products overlap in many areas, and each offers well-balanced programmability and ease of use. Although both offer lots of vertical-discipline features, we found Visio Technical somewhat more suitable for general business and marketing tasks and Actrix for precise technical drawing and AutoCAD interoperability. Both offer excellent technical-drawing power at a very reasonable cost.

Actrix Technical. List price: $349. Requires: 16MB RAM; 80MB hard disk space; Microsoft Windows 95, 98, or NT 4.0. Autodesk Inc., San Rafael, CA; 800-964-6432; www.autodesk.com; *406 at www.pcmag.com/infolink.*

Visio Technical 5.0 Plus. List price: $349. Requires: 16MB RAM; 15MB hard disk space; Microsoft Windows 95, 98, or NT 4.0. Visio Corp., Seattle; 800-248-4746; www.visio.com; *407 at www.pcmag.com/infolink.*

*Estimated reseller price for models 390/2OU-7OU. Actual prices may vary. mhz denotes microprocessor internal clock speed only; other factors may also affect application performance. gb=1 billion bytes for HDD capacity. PCs referred to in this ad include an operating system. IBM product names are trademarks of International Business Machines Corporation. Intel, Inside and Pentium are registered trademarks and MMX is a trademark of Intel Corporation. © 1999 IBM Corp. All rights reserved.

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- Diamond Sonic Impact Wavetable Sound Card
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A Second Cup of Java

Sun Microsystems' Java 2 SDK provides the richest array of functionality yet for developers and users.

By Rich Dragan

The Java 2 SDK, from Sun Microsystems, puts unprecedented programming power into the hands of Java developers and gives enhanced functionality to end users. The new Java standard appears to be the richest ever, though end users may have to wait to reap all the benefits promised in this release.

SWING

The most visible improvement in Java 2 is its set of classes that lets programmers create highly graphical applications and applets. These so-called *Swing* classes provide a library of widgets from sophisticated objects such as trees, tables, and graphically rich controls that rival the features of "native" operating systems such as Windows 98/NT and Unix. Better yet, these Swing classes have a pluggable look and feel, which means that a Java application can change its appearance to mimic Windows or Unix's Motif on the fly.

Developers can even create their own visual styles. This chameleon-like flexibility will be a winning feature to vendors who are considering writing a Java application that needs to run on more than one OS or hardware platform.

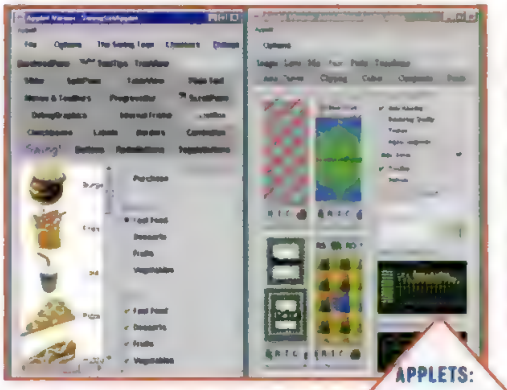
Along with the Swing classes, additional features that will let Java programs compete alongside native versions include the ability to drag and drop files across Java 2 applications and greatly improved 2-D graphics capabilities for real-time graphics and animation. In short, whatever native applications can do, Java 2 applications can do just as well, in functionality if not performance.

PERFORMANCE

To test performance, we ran our JMark 2.0 Java benchmark test against the previous release of Java (JDK 1.1.7B). We saw only a 1 and 3 percent increase in performance on our Processor and AWT Playback (graphics) tests, respectively; almost all other tests showed a modest decrease in performance.

Sun claims performance enhancements to the Java 2 release include faster garbage collection and many optimized "core" classes, better synchronization, and native support for threads for Sun Solaris. (Our benchmarks don't test these new features.)

Under the hood, Java 2 adds new features that will keep corporate developers happy as they write applications for the new millennium. There are a richer array of container classes for common data structures, like linked lists and maps. This addition makes up for the relatively weak support for containers in earlier versions of Java. Now Java programmers can choose just the right container to fit the problem at hand.



APPLETS: *Java 2's 2D API provides rich 2-D graphics for the next generation of Java applications.*

For database and enterprise developers, Java 2 includes Version 2.0 of the Java Database Connectivity (JDBC) standard for connecting to corporate data. Already a successful standard backed by many vendors, JDBC 2.0 adds support for bidirectional cursors (for scrolling through data forward and backward), batch updates, and new support for SQL3 data types. Support for CORBA is also included as standard equipment with Java 2.

Security is an important enterprise concern, and the new security model in Java 2 is one of its most improved features. Early versions of Java used an all-or-nothing approach, in which Java applets were restricted from local file access (or even printing) by running in a Java sandbox.

The new approach to security uses standard X.509 certificates to authenticate what a Java application can and cannot do, using a sophisticated and finely grained policy-based security model. This means that administrators can easily grant permissions to Java applications to corporate resources like database servers and printers, while preventing wayward behavior.

In the midst of its lawsuit with Sun, Microsoft has no immediate plans to support the Java 2 standard. For now, in order to see Java 2, you'll have to rely exclusively on Sun's JVM (included in the Microsoft Navigator Java 2 SDK).

The good news is that, via a plug-in, Java 2 will run on Internet Explorer and Netscape. When we tested sample pages that made use of Java 2 code, we found that downloading the 9MB plug-in worked reasonably well, though this initial download took a few minutes even on a fast corporate LAN.

Java 2 raises the bar for Java functionality and reasserts Sun's control of the platform for the near term. In a perfect world, all vendors should be striving to keep up with the latest and greatest in Java functionality, represented by the new Java 2. For developers, it's the best Java we have, though the benefits for end-users are still to be seen. **Java 2 SDK.** List price: Free download. Requires: 32MB RAM; 30MB hard disk space; Microsoft Windows 95, 98, or NT 4.0. Sun Microsystems Inc., Palo Alto, CA; 800-786-7638, java.sun.com; *404 at www.pcmag.com/infolink.*

PERFORMANCE TESTS

JMark 2.0

The JMark 2.0 program tests the performance of the Java Virtual Machine you might find inside a Web browser. JMark includes tests for both the processor and graphics (AWT) subsystems. We tested on a Pentium/200 PC with 64MB of RAM, running Windows NT 4.0. For more on JMark go to *www.zdnet.com/zdbop/jmark/jmark.html.*

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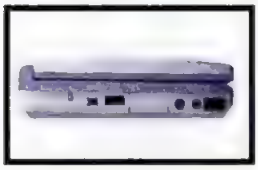

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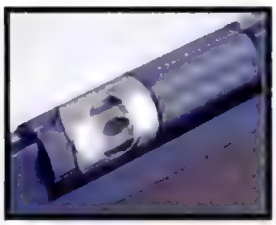

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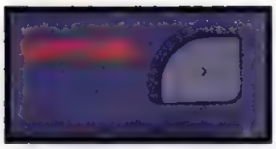

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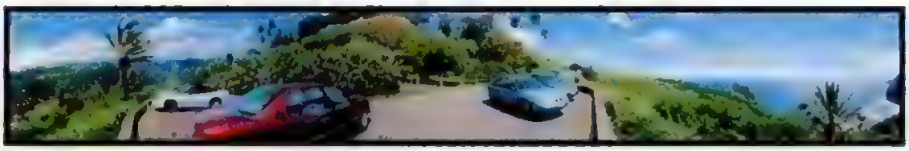

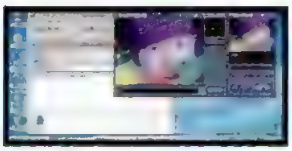

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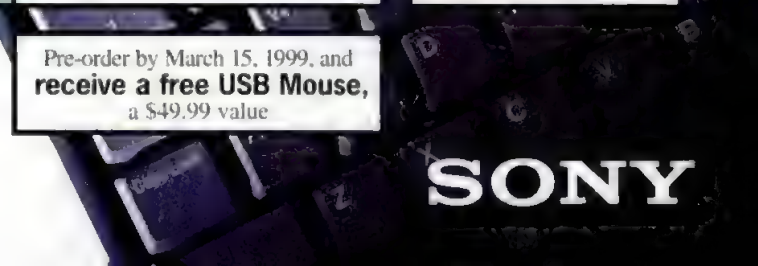

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by Naba Barkakati

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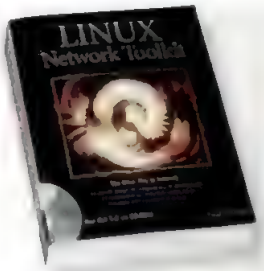

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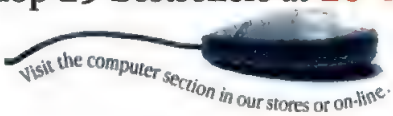

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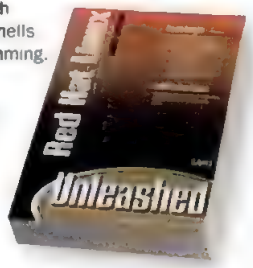

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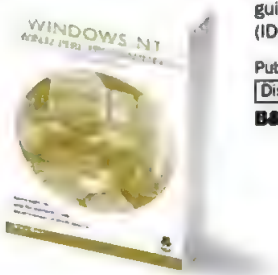

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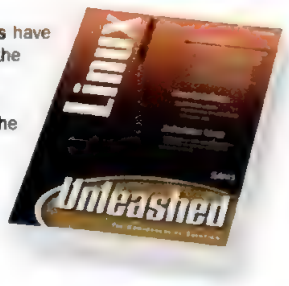

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The Thinner, the Better

Applica for TSE is an important part of a low-overhead, zero-client network solution.

By Steve Rigney

The goal of thin client technology is to simplify the desktop hardware and reduce costs. But many thin clients still rely on processors, client software, and network protocols to request data and applications from the central server. In an effort to eliminate all technological and financial overhead, Concurrent Controls has developed a zero-client solution called Applica for TSE Version 1.0 (starting at $395 list, for 4 users). This Microsoft Windows NT Server Terminal Server Edition (TSE) add-on lets you have 32 simultaneous users controlling a single PC using only VGA monitors, keyboards, and mice. It's particularly aimed at data entry and workgroup applications where standardization and simplicity are key.

Applica for TSE pricing becomes more complicated when you look at the entire solution you'll have to implement. If you aren't using Windows NT Server TSE already, you'll need to purchase it ($1,129 list, for 10 users), along with a multiuser server adapter and multidisplay adapters (MDAs). Concurrent Controls doesn't sell Windows NT TSE nor the hardware. It does, however, support existing products, including Maxspeed's adapters and MDA. You can purchase the Maxspeed four-port adapter for your Windows NT TSE server for $1,000 (street), and you can get the Maxspeed single user MDA for $400 (street). If you don't already own one, you'll also need to add a high-end PC to the brew with enough speed, memory, and disk space to hold all of your applications and data, as well as power enough to run Windows NT TSE.

EASY INSTALL

We found Applica for TSE one of the easiest multiuser products on the market to install. All we had to do was insert the multiuser server adapter in our Windows NT TSE server and load the drivers that come with Applica. We then created the Windows NT users and security information on our TSE server. The entire configuration uses Windows NT TSE menus; Applica runs in the background and creates a connection between the multiuser adapters and the Windows NT TSE server.

After we installed the controller and configured Windows NT TSE, all we had to do was connect the MDAs. The MDA boxes reside at the client's locations and provide a port for a standard VGA monitor, PS/2 keyboard, and PS/2 mouse. The Maxspeed MDAs we used included two serial and one parallel port, so we could also attach a local printer to the MDA, something you can't do using standard Windows NT TSE clients.

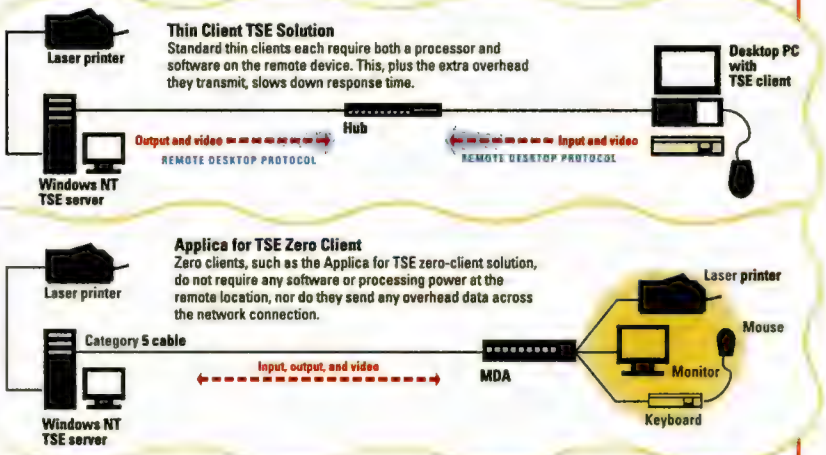
The MDA devices connect to the server using Category 5 UTP cable at distances up to 500 feet. If you're using Maxspeed hardware, you can install up to 8 Maxspeed controllers in a single Windows NT TSE server and service up to 32 simultaneous Applica users. Note that you may need to purchase an external chassis to accommodate the extra controllers. Each adapter requires only an I/O base address, so most servers should have enough available resources to handle 8 controllers.

THE THIN CLIENT EDGE

By comparison, Windows NT TSE without Applica requires a full-blown PC with a processor and a hard disk at each client's location. Likewise, with Windows NT TSE alone, you have to install Windows NT TSE client software on all of the PCs, which requires even more installation time. Unfortunately, Applica doesn't work with dial-in users, but because it runs in conjunction with Windows NT TSE, you can still rely on Windows NT TSE and NT RAS to handle remote connections.

Concurrent is proud of Applica's 64-Mbps bus speed performance, and it should be. Windows NT TSE clients alone require the aforementioned processor and Windows NT TSE software on the remote PCs to send and receive the data running over the Remote Desktop Protocol (RDP). The time it takes to process the software and the extra bandwidth required for the RDP protocol to travel the network reduce the client's response time. Because Applica clients don't require any overhead, they send only keystrokes and screens across the network cable and can operate at the same speed as standalone desktop PCs. The only bottleneck for Applica users is the speed and load on the Windows NT TSE server. Even other terminal server products, such as Citrix MetaFrame, which can use dumb terminals at the client location, have a proprietary protocol to communicate with the server.

If you have already invested in thin client hardware or most of your Windows NT TSE users are remote, you probably don't need to invest in Applica for TSE Version 1.0. But if you want to eliminate the maintenance of client PCs or need to increase performance, Applica is a good solution. **Applica for TSE Version 1.0.** List price: For 4 users, $395; for 32 users, $1,449. Concurrent Controls Inc., South San Francisco; 800-487-2243, 650-873-6240; www.conctrls.com; *902 at www.pcmag.com/infolink.*



Proxy Server Solution

WinGate 3.0 Home works with nearly every Internet client application without tweaking or hair-pulling.

By Les Freed

Deerfield.com's WinGate 3.0 is the latest incarnation of the company's popular proxy server package. This version boasts new pricing and several new server features, but the big news is WinGate's new client software.

WinGate comes in three versions. WinGate Home ($39.95 list, for three users) provides a quick and easy way to share your dial-up modem, ISDN, cable modem, or DSL Internet access across your home or small office LAN. WinGate Standard ($79.95 list, for six users) adds proxy caching, site blocking, and additional management features to the Home package. WinGate Professional ($299.95 list, for unlimited users) adds a wealth of user management, auditing, and security features to the Standard package.

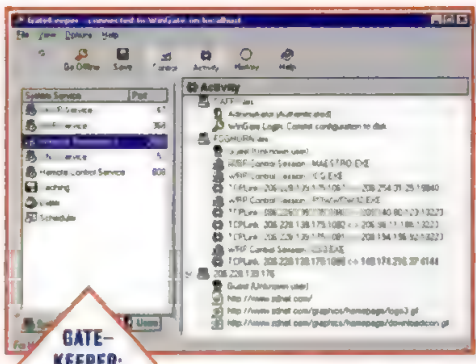
All three versions install using the same wizard-driven installer program. Your installer key (purchased from Deerfield.com by phone or over the Internet) determines which version you can install from the company's Web site at *www.wingate.net*.

Like other proxy server products, WinGate provides a suite of standard proxy services, including NNTP news, POP3 and SMTP e-mail, and HTTP Web browsing. But WinGate 3.0 also includes a new Winsock redirector proxy that, when used with WinGate's client software, redirects all of a client PC's IP traffic to the WinGate server. The Winsock redirector lets you use any Internet application through the proxy, even if the application wasn't designed to operate through a proxy server, and since the redirection to the proxy server is done in the Winsock driver, you won't have to reconfigure every application on every client PC. Some other proxy products (notably Microsoft's Proxy Server 2.0) have a similar feature, but WinGate's client is more complete and easier to use.

We tested WinGate 3.0 with several Internet applications that we felt don't work well or are difficult to configure with a proxy server, including AOL 4.01, CompuServe 4.0, Microsoft's NetMeeting, Mirabilis' ICQ, Tribal Voice's PowWow 32, and VocalTec's Internet Phone. With WinGate, all worked without a hitch and without any additional configuration.

The WinGate client software includes a control panel applet that lets you turn the Winsock proxy on and off. This is handy for laptop users who want to use the proxy server at home or at the office but who still need to use their normal dial-up networking connection when traveling.

The server side of WinGate is easy to install and configure. The server can run on any Microsoft Windows 95, 98, or NT 4.0 system. The server loads as a service and displays an icon in the system tray; double-clicking on the tray icon starts WinGate's Gatekeeper configuration, monitor, and logging program.



GATEKEEPER: *WinGate's own configuration and monitoring program.*

WinGate 3.0 Home. List price: For 3 users, $39.95; WinGate 3.0 Standard, for 6 users, $79.95; WinGate 3.0 Professional, for unlimited users, $299.95. Deerfield.com, Gaylord, MI; 517-732-8856; www.deerfield.com; *901 at www.pcmag.com/infolink.*

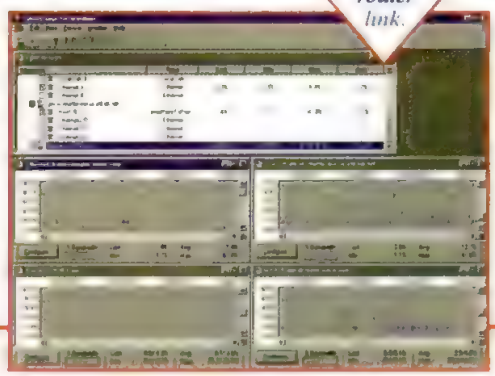
Cracking Traffic Code

Neon Software's CyberGauge 2.0 makes sense of ambiguous network traffic information.

By Steve Rigney

Most Internet routers provide information on the amount of traffic coming and going through your network connection. Unfortunately, most of this information is available only in a cryptic text-based format that is difficult for network administrators to use. Neon Software has developed a product that makes sense out of all of the garble. CyberGauge 2.0 for Windows (starting at $295 list, for a five-user license, and up) works with Microsoft Windows 9*x* and NT and provides easy-to-view information on your router traffic.

CyberGauge is sold based on the number of devices you want to monitor. For example, a 5-device license will cost you $295 (list); a license for 20 network devices retails for $695. This price is a lot less than you'll pay for other traffic monitors, including the $5,000 HP OpenView PerfView. But you don't get all of the same features, such as the ability to auto-discover your network devices and monitor hardware device problems.



LOOKING GLASS: *CyberGauge's reports help monitor any router link.*

The product was a snap to install. The only information the administrator must provide is the IP address of the router and the SNMP password. CyberGauge lets you simultaneously monitor the traffic on multiple devices but doesn't provide a graphical map of your routers, locations, and hardware status.

CyberGauge uses standard SNMP requests to gather the information from the router. Though this is not new, and several SNMP managers exist on the market, CyberGauge's ability to graph this information makes the product unique. CyberGauge will monitor the traffic traveling through any router device that supports SNMP MIB II and keep a detailed log of that information. Note that you won't be able to see what user or application is using the most bandwidth.

Perhaps the best feature of CyberGauge is its graphical reporting tool. The utility provides a different color for each router device and shows its performance on one chart. By default, CyberGauge polls the routers every 15 seconds, which is more often than is really necessary. We suggest that you run the utility for a couple of days to see an Internet usage trend.

CyberGauge 2.0 for Windows. List price: For a 5-user license, $295; for a 20-user license, $695. Neon Software Inc., Lafayette, CA; 800-334-6366, 925-283-9771; www.neon.com; *900 at www.pcmag.com/infolink.*

Ending Net Bottlenecks

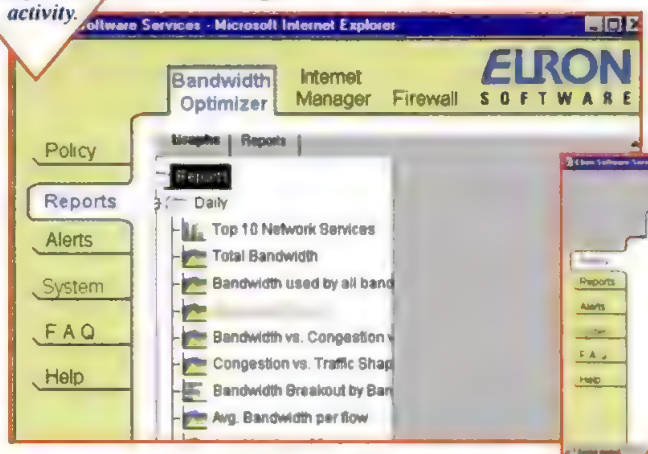
Elron Bandwidth Optimizer v2.0 unlocks the door to faster and more efficient network usage.

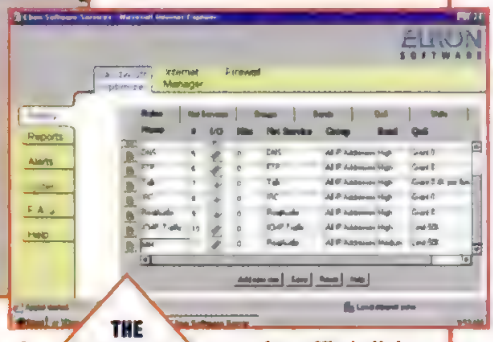
By Robert P. Lipschutz

Does your small or medium-size network suffer from slow Internet access? Now you can diagnose and, in some cases, correct this problem with Elron Software's Elron Bandwidth Optimizer v2.0 (starting at $3,995 list, for 25 users). The product documentation outlines a smart approach: First understand network traffic, then act to improve it.

Bandwidth Optimizer sits at the periphery of your network and provides a view of Internet usage with a variety of reports and charts. In turn, you use this information to prioritize and shape the traffic that travels in and out of your network.

KEEPING TRACK: *Flexible daily, weekly, month, and yearly reports show short- and long-term activity.*





THE RULES RULE: *Bandwidth rules are the key to shaping traffic; here, a rule to limit RealAudio traffic is highlighted.*

TRACKING TRAFFIC

Unlike highway automobile traffic, network traffic can be elusive and difficult to see. To help you better understand your network traffic, Bandwidth Optimizer gathers packets traveling to and from the Internet and creates reports and charts based on what it sees. We created useful charts and reports based on top users and type of service (HTTP or RealVideo, for instance) over time and in real-time. Bandwidth Optimizer's charts and reports made spotting traffic patterns that were causing network congestion easy.

Once you "see" your network and can spot patterns, you can create a network bandwidth-management policy consisting of a set of prioritized bandwidth rules, and that will, in turn, shape future network traffic. The rules match combinations of users and groups, designated by IP addresses, and service types like HTTP, with a designated band of your available bandwidth. Further honing can be done by assigning a specific quality of service to a particular bandwidth rule and indicating specific minimum and maximum flows. The result is that when network traffic is light, all users and services get the bandwidth they want, but when congestion occurs, the bandwidth rules are used, allowing higher priority traffic through and slowing or stopping lower-priority traffic.

The product doesn't integrate with common user databases such as Novell NDS or a Windows NT domain, so when monitoring or shaping policy, users can be identified only by their IP addresses. For those networks that use Dynamic Host Control Protocol (DHCP), administrators will have the extra headache of matching up users with their current dynamically assigned addresses.

Developing a traffic policy with Bandwith Optimizer has three primary uses. First, it's useful for those networks that need to segregate "good" versus "bad" traffic, meaning for instance, networks that have business communications and Quake tournaments running simultaneously. Second, for those small and medium-size companies that are hosting their own Web site or mail server, Bandwidth Optimizer can be used to prioritize incoming-versus-outgoing traffic. Finally, if you're prepared to put some time into analyzing your traffic patterns, some of you might find joy in freeing up a few kilobits of bandwidth for individual users or applications. This can be especially useful for those connecting to the Internet through dial-up, low-bandwidth circuits such as analog, or ISDN lines.

FITTING IN

Elron suggests Bandwidth Optimizer run on a dedicated Windows NT machine with two NICs if you wish to do both monitoring and traffic shaping (it's certified with the 3Com 3C509 and 3C905 models). You deploy the product between your network and Internet router, but inside your firewall or proxy server if you have either of these.

For management, you can use Microsoft IE 4.01 or Netscape Communicator 4.5 or later. A browser-based interface typically means easy remote management, but the large Java applet used for configuration makes management over slow links tedious. The company suggests that you also change your browser's cache settings to reload pages every time, so the Java applet will always show the latest configuration information.

KNOWLEDGE = POWER?

The challenge of this product is that it gives administrators the knowledge to shape the traffic flow, but improvement of traffic flow can't be guaranteed. In addition, the lack of integration with common user databases such as Novell NDS trees or Windows NT domains leaves the network administrator with only the TCP/IP addresses to distinguish users and groups on the network.

Another concern is that creating policies about bandwidth usage can take a lot of time and is sure to be controversial. Administrators will have to consider carefully what the impact will be on low-priority users and applications. (And when network traffic is light, these policies will have no effect, as everyone gets all the necessary bandwidth each one needs.)

If your users are experiencing network and Internet access delays and a faster connection is somehow out of reach, Bandwidth Optimizer will give you vision and control over your network bandwidth.

Elron Bandwidth Optimizer v2.0. List price: For 25 users, $3,995; for 100 users, $5,995; for 1,000 users, $14,995. Elron Software Inc., Cambridge, MA; 617-914-5000; www.elronsoftware.com; *903 at www.pcmag.com/infolink.* PC

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Still the Zip of Choice

By Edward Mendelson

The ZIP compression format became the universal standard because users preferred it, not because of the approval of a corporation, an agency, or a consortium. So there's no built-in support for ZIP archives in any popular operating system, and users have to choose a ZIP manager utility before they can use any file in a ZIP archive. All indications—including your comments—are that Niko Mak Computing's WinZip 7.0 is the most popular ZIP utility, but there are rivals that deserve your attention.

Among the many points in WinZip's favor are reliability, clarity, ingenuity, and a vast range of intelligently designed features. The program displays the contents of ZIP files in a customizable listing, and you can right-click on any file and view or run the file, add a comment to it, or otherwise manipulate it.

The program also makes it easy to create ZIP archives, including multidisk archives for files that are too large to fit on a single disk. A wizard interface is available for beginners, but experts can switch the wizard off.

The most significant alternative to WinZip, as some of you pointed out, is Mijenix's ZipMagic 98, which tricks Windows into treating ZIP archives as if they were ordinary folders; you open and manage them in Windows Explorer. With WinZip (and all other ZIP managers), if a setup program in a ZIP archive uses data in a second file in the archive, you have to extract both files from the archive before you can run the setup program. Using ZipMagic, you can leave the files

in the archive and the program decompresses them on the fly, so the setup program can use the files as if they were in ordinary folders. Also, with ZipMagic you use Explorer for virtually all file management: Once you get used to ZipMagic's smooth integration into Windows, it's hard to go back to anything else.

You also mentioned FreeZip, a bare-bones free utility that uses DOS boxes to display ZIP contents; Canyon Software's simple and effective Drag and Zip; and the freeware PowerZip. No one mentioned Microsoft's ingenious Compressed Folders, found on the Microsoft Plus for Windows 98 CD-ROM, which displays the contents in ordinary Explorer windows (like ZipMagic) but doesn't decompress on the fly, as ZipMagic does. Expert users will probably want both WinZip (for the management features) and ZipMagic (for its transparency and ease of use).

The Best Products of 1998

By Nancy Hirsch

After publishing our annual best-of-the-year issue, we opened up the floor to our readers and let them sound off about their favorite—and not-so-favorite—products of the year. Amid the onslaught of responses, we found more than a few surprises.

Most of the comments—overwhelmingly positive ones at that—were on BeOS Release 4. As one reader said, "With its slick interface and blink-and-you'll-miss-it processing speed, you may be surprised to find the computer you thought was slow (because of Windows) suddenly performing tasks as fast as you can throw them at it." Apparently, BeOS provided a much-needed break from Microsoft Windows.

Windows 98 did get a few best-product nominations, but responses were mostly negative. One vote for worst of the year went to "Windows 98, hands down. Buggy, incompatible, and designed to give the knockout punch to Netscape, and little else."

One product whose reader comments didn't surprise us was the Apple iMac, which seemed always to incite an argument or two. One reader was certain the iMac was "the worst PC of the century," and someone even wondered whether "the people who buy iMacs also collect Beanie Babies." There were some iMac supporters, such as the one who appreciated the iMac "for changing the classic way we look at computing and addressing the needs of new users."

The Web browser Opera also has a lot of fans among our readers. Most people praised its simplicity and cheered it as "the very best browser for the Web! It is perfect for all-too-common dial-up connections."

The AMD K6-2 processor received its fair share of mentions

as best of the year—not only because of its power and low price, but also because it provided a healthy dose of competition for Intel. As one reader proclaimed: "Go, AMD! Competition is good for everyone."

Another surprise was that odes to the omnipresent Palm computing platform were nowhere to be found. But we doubt this means Palm enthusiasm has died out, considering the responses we've gotten in the past.

What does all this prove? For one thing, finding a great product that isn't made by Microsoft (or Intel or Netscape, for that matter) is pretty satisfying—and it's even better when that product gives Microsoft some healthy competition.

www.secondlooks.com

Tell us what you think.... How do you like the new products you're using? Second Looks is your forum for feedback. Join us online to tell us about your experiences. We discuss a different new product each week and summarize your comments here. Following are some of your comments from our discussion of the best products of 1998.

I'd have to say that the most impressive experience *for me this year was using BeOS R4 for Intel. Sure it's young, but BeOS is already a lot more stable than Linux was at its age. BeOS strikes the perfect balance between having a useful GUI and allowing you to get real work done with a command line. Finally, BeOS is fast, fast, fast, and it can handle whatever you throw at it.*

—Bob Stratton

I think people are naming the K6-2 *as best of the year because it was significant in expanding the lower-end PC market (forcing Intel to abandon its high price/high margin strategy). First AMD cleared out the old Pentium MMXs, then it publicly embarrassed the early Celeron-based PCs. As a result, the new Celerons are a lot faster, the Pentium IIs are a lot cheaper, and there are alternatives to Intel inside. And the fact that the K6-2 delivers good performance for the money doesn't hurt!*

—Jason Maher

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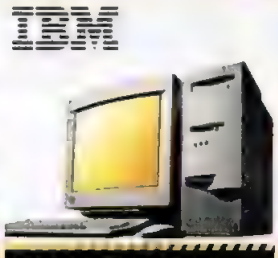

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A Wireless Entanglement

We're on the eve of the personal-area network. Personal computers, PDAs, cellular phones, and the like don't talk to each other, but they should. And they will. Bluetooth (named for Denmark's first Christian king, not a dire dental condition) is a specification first advanced by Ericsson as an extension to GSM, the European protocol for cellular communications. It's a combination of software, communications protocols, and a tiny radio transceiver on a chip that will let devices communicate with one another over short distances (up to 40 feet). Bluetooth devices can communicate at up to 720 kilobits per second, and they can handle phone-quality voice as well as data. Version 1.0 of the specification will be published this spring, and the first products are due out by the end of 1999.

There's a lot to like about Bluetooth. It is wireless, can work through walls or from within your briefcase, and is small and inexpensive. The protocols include encryption, and multiple devices—up to 80 of them—can operate in a network.

In a typical scenario, your Bluetooth-equipped cellular phone synchronizes the numbers in its memory with the favorites or most frequently accessed numbers in your PDA. Messages arriving on your pager are routinely logged into the to-do list on your laptop and your PDA. Another example has the cellular phone in your briefcase providing an Internet link for your laptop and PDA, so that you can have up-to-the-second intelligence and market information on your desktop, even during a meeting.

Bluetooth also enables some new kinds of devices, such as wireless headsets. You can key a headset to your laptop, cellular phone, or PDA to use voice communications or commands.

It sounds great, and it is. But Bluetooth's greatest strength is its Achilles' heel, too. It uses the unlicensed 2.4-GHz band, which is shared by wireless LANs, urban and suburban wireless telecommunications systems such as Metricom, and most notably microwave ovens. Even a properly operating microwave oven can be a jammer for devices that use Bluetooth, because it eats up bandwidth.

Spread-spectrum and frequency-hopping devices can communicate at the edges of the interference, but with greatly impaired throughput. All of the devices on this band have the potential to conflict with one another, but like computers sharing an Ethernet connection, collisions are transitory and result in degraded throughput, not lost data. Every Bluetooth device has a unique ID burned into its chip. Internet proponents wish that this were an IP address, not just a serial number. It could make as-yet-uninvented modes of communication easier.

I would like Bluetooth better if it weren't a radio-only specification. Unless the FAA reverses its long-standing ban on intentional transmitters (which I'd advise it not to do), you won't be able to use Bluetooth devices on airplanes. Also, there is the potential for interference that you can't see or do much about. For instance, you might not want to inhabit the offices directly above or below those of *PC Magazine*, with its always-busy wireless LAN. I'd be happier if the same protocols could switch seamlessly to infrared and hardwired communications.

Bluetooth has no operating-system support. Microsoft is not a member of the Bluetooth SIG, because although it has hundreds of members, voting is limited to the five founding members: Ericsson, IBM, Intel, Nokia, and Toshiba. Unless Microsoft is granted voting rights, it won't participate. Intel's Bluetooth marketing manager, Simon Ellis, says this isn't a problem, because Intel is building a driver that will function much like your serial-port driver but will add Bluetooth devices to your range of choices.

If the driver implementation is anything like the unfriendly implementation of USB drivers, Bluetooth could get the cold shoulder from users. There aren't nearly enough software companies in the Bluetooth SIG for my taste; you don't find out the real problems until software gives the hardware a workout. Also, all SIG members must give up any intellectual property they develop for Bluetooth to the group. I find the SIG charter somewhat distasteful; companies contributing intellectual property should have some kind of vote.

Bluetooth security allows for both private and public devices and uses streaming encryption with up to 128-bit keys. Whether the implementation will be transparent or will interfere with the ease of forming ad hoc Bluetooth networks remains to be seen. For more on Bluetooth, check out *www.bluetooth.com*. PC

Bluetooth uses the 2.4-GHz band, which is shared by wireless LANs, wireless telecom systems, and most notably microwave ovens.

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MP3 Spells Disaster

The MP3 format and the trading of music on the Internet will destroy the music industry within the next two years. Fact is, the music business is counterproductive and ripe for change. The RIAA's attempt to kill off the Diamond Rio player was the last straw as far as public tolerance is concerned. The music industry, in a vain attempt to protect itself, killed the DAT format and has recently lobbied various governments to impose strict penalties for bootleggers.

Our own Congress has outlawed reverse engineering with the passage of a ludicrous electronic copyright bill. Now the record industry is experimenting on Canadians by trying to impose a $2.50 "royalty" tax on each blank CD-R disk sold. Once enough countries stupidly pass this kind of tax the industry will come to our Congress with precedent.

But it's already too late. MP3 bootlegging is rampant, and that's the record industry's own fault. It began with the self-imposed destruction of the singles business. Singles dominated the world right until the dawn of the CD and cassette. But singles on CD and cassette are impractical. Nowadays, a person usually has to shell out $16.95 for an entire CD, which seldom contains more than two decent songs. Most popular bands have been one-hit wonders, and the majority of them were incapable of ever producing an album full of songs. MP3 fills the gap.

To make matters worse for itself, the industry is overcharging for CDs, which should have been selling for less than $10 for at least the last five years. There's no rationale for a CD to cost more than a cassette—a linear medium with moving parts! Few record sellers will even discount CDs, because co-op advertising money would be pulled from these stores. This co-op ad money, paid by the record labels, has been used to prop up high prices. The public is sick of it.

Compound this with the general bad reputation recording companies have developed over the decades. Stories about how they rip off their own artists abound. Everyone has heard about bands that were never paid their royalties or that signed away their lives and got nothing in return. This industry has not endeared itself to the public.

Enter MP3, a compression method that turns a 3-minute song into 3MB of CD-quality audio that can be converted to a WAV file and burned on a CD-R. The trading of commercial tunes over the Net in this format is rampant. Take a look at IRC; do a /list *mp3* to witness the mania. (Go to *www.mirc.com* to download an excellent IRC client. For an MP3 player I suggest Winamp at *www.winamp.com*.)

I recently went on a couple of these sites and discovered that every single hit record on the Billboard chart could be illegally downloaded. The MP3 Web sites have been effectively shut down by the record companies, but real-time online lash-ups such as IRC can't be so easily stopped.

The best MP3 distributors are sending files from fake or hacked IP addresses that can't be traced back to the real sender. I'm told IRC is just the tip of the iceberg of potential bootlegging. The top IRC system, EFnet, can handle 40,000 to 50,000 simultaneous online users; ICQ can have 500,000. AOL can have a million! The trading of MP3s is unstoppable. The laws against it will do nothing.

More bad news: Most collectors of MP3s are the traditional young buyers between 12 and 24. The majority are minors, not subject to adult laws and unlikely to be prosecuted for distributing or collecting bootleg recordings. Some have CD burners, but most keep songs on their computers in MP3 format and play them natively. The latest Microsoft media player now handles MP3! I'd like to see what develops if the RIAA sues Microsoft over this. Meanwhile, those kids with CD burners make disks for their friends. A straw poll done at a private junior high school in Berkeley indicated that *none* of the kids had bought a CD in the past year.

More interesting is the sheer number of musicians who have embraced MP3 and use it as a marketing tool. This also has music industry execs spooked. They're losing control of the content and the channels of distribution. In short, they're toast.

I sure don't condone illegal activity, but I'm not surprised. This is a trend that a greedy, cavalier industry brought on itself. It expects morality from its customers while producing songs that advocate otherwise. Irony abounds. As far as I'm concerned, the music industry deserves the worst for what it did to DAT. Obliteration seems just.

The trading of MP3s is unstoppable. The laws against it will do nothing.

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John C. Dvorak's

INSIDE TRACK

Expect a lot of **backtracking** by Intel in 1999 regarding its microprocessor strategy. With the low end being chipped away by competitors and the demand for high-end systems **looking bleak,** Intel has had to adjust its cocky thinking. Moving away from the clunky Slot 1 and back to less expensive chip packaging, the company hopes to stave off the competitors in the hot low end.

Intel has told the trade that the low-priced Celeron has become the "fastest-ramping Intel processor product in history," but this seems to be for **reasons other than raw popularity.** The **late-to-market** concept comes to mind. I'm also not convinced that the Celeron, which began with a bad rap due to its lack of cache, is going to carry the load for Intel. The name also bugs me.

Intel goes through a lot of trouble and spends a lot of money to **develop its chip names.** The name *Pentium* has a certain flair, especially because it would have otherwise been the 586. I think *Celeron* is derived from *accelerate* and *electron.* Sounds **jazzy** if that's what you hear. But I actually hear *salt* and *celery,* with **emphasis on *celery.*** *Celery* implies *bland,* and I think that's the perception people have of this chip: It's bland. Probably nothing a fortune in advertising can't correct. I just hope the company doesn't bring out the Turnipium, Carrotron, or Cabbagium as follow-up. Then I'll know for sure that the place has been **taken over by vegetarians.**

I think Celeron is derived from accelerate *and* electron. *But I hear* salt *and* celery, *with emphasis on* celery.

Meanwhile, Intel will come out with core logic with integrated graphics this year. This is to compete with the Cyrix thrust. Intel thinks that on the very low end, it's possible to build **a cheap machine without any internal expansion,** relying only on USB (and eventually FireWire) for peripheral expansion, and leaving perhaps only an AGP slot in the machine (if that). This is the beginning of the end for the PC as we know it and may actually signal a potential platform shift. This also means the age of the sub-$500 machine has begun.

Manufacturers should **incorporate Ethernet** onto their motherboards if they are going to make cheap machines. I say this because the primary computer thrust at the latest Consumer Electronics Show was the **home network,** led by various initiatives including the HomeRF Consortium as well as phone-line mavens (Home Phone Networking Association leading the way), all hoping to tap into the unused spectrum on the home phone's wiring.

The problem I see here is that any of these things rolling out at CES is **a kiss of death.** This is the show that promoted analog HDTV, and where Microsoft Bob was rolled out. I was at Bob's booth years ago, and from the reaction of the showgoers you'd think **Microsoft Bob** was going to take over the world. I hate to break this to everyone, but computer networking—no matter how plug-and-play—is **not ready for the prime-time consumer.** I still have one machine on my chain at home that won't communicate with the others properly, and I've been working on fixing it for months.

To complicate matters further, apparently a 56-bit encryption security code has the **government spooked.** According to *Electronic Engineering Times,* the National Security Agency is concerned about strong encryption on the home network. In fact, 56-bit isn't that strong compared with triple DES or some other uncrackable codes. Exactly why our own government would be **freaked about encryption** for use **within the home** is a mystery. What's next? Death squads?

The encryption is to prevent one home-RF network from interfering with another network next door. The NSA thinks that 40 bits is enough. Experts say that someone can **camp outside** your place and crack 40 bits and **spy on you.** What concerns me about the *EE Times* article is the constant references to the NSA and its approval of this or that algorithm and this or that scheme, as if the **NSA were a domestic regulatory agency.** Is it? Since when?

The fear, of course, is that one of these home networking systems will get exported, and the next thing you know the Iraqis will be using it against us. Memos about **tainted hummus** will go unencrypted, and we'll be doomed.

The joke of this is that the encryption bandwagon rolls on overseas without us. In case you're looking for a way to encrypt files on your computer, for example, there are numerous Web sites in England and elsewhere where excellent strong-encryption software is available. While we make a fuss over PGP here in the states, take a look at the **excellent multicipher freeware version** of Scramdisk out of the U.K. at *www.hertreg.ac.uk/ss.* This system sets up a scrambled virtual disk that is both secure and easy to use. You don't end up with a bunch of individual scrambled files, each with its own password. You have one virtual disk. More important, the system uses a variety of schemes including **triple DES,** which all experts say is uncrackable, period.

Athough home networking is a hot topic, it's **a long way** from becoming a force in the consumer-electronics arena, no matter what all these NSA and marketing folks think. The specifications on the HomeRF network are interesting because RF networks have traditionally been expensive, slow, and unreliable. **No matter, let's do it anyway!** The home network will operate a spread-spectrum–type system at 1 and 2 Mbps, **too slow** to generate any enthusiasm. Worse, the HomeRF group hopes to keep the cost at about $200 per node, which is still **too expensive** for 1 Mbps. Hey guys, you can buy a 10/100 Ethernet card at a screwdriver shop for $9! Get a clue. PC

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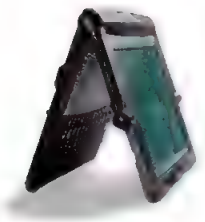

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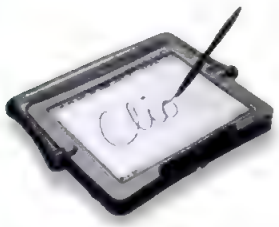

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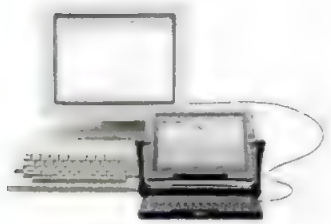

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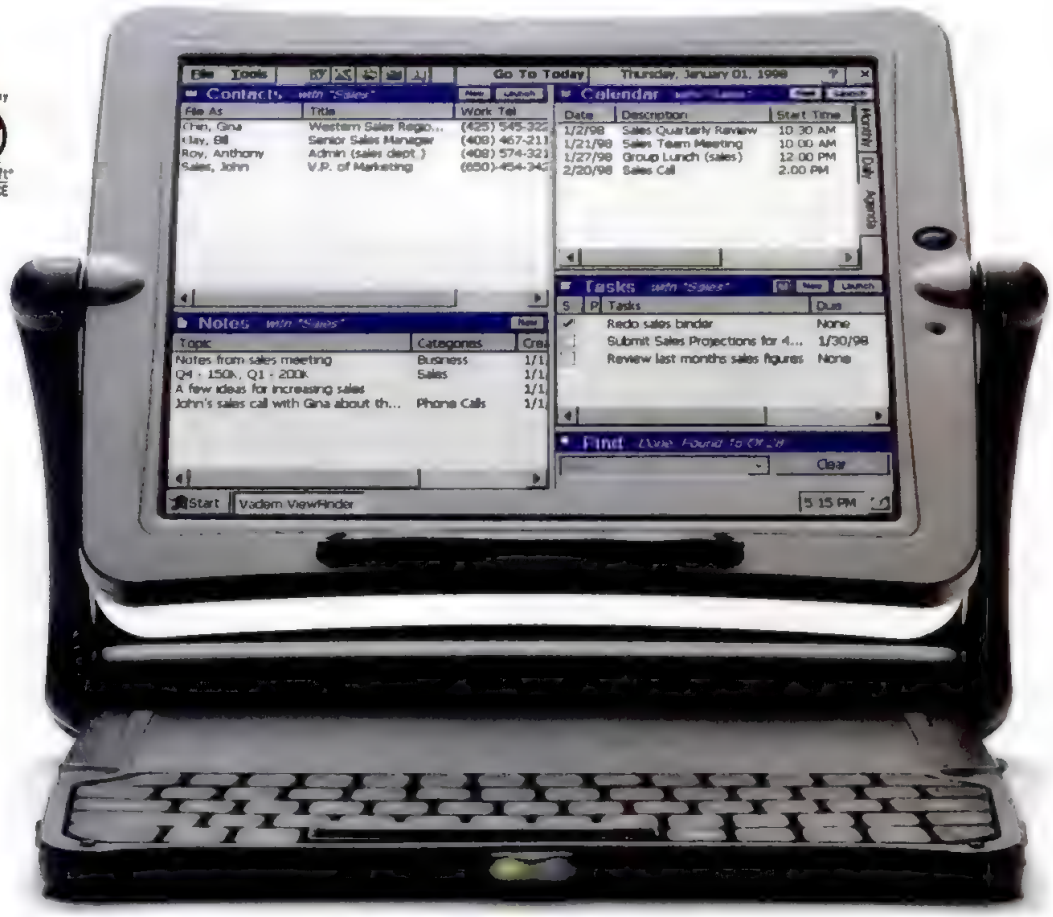

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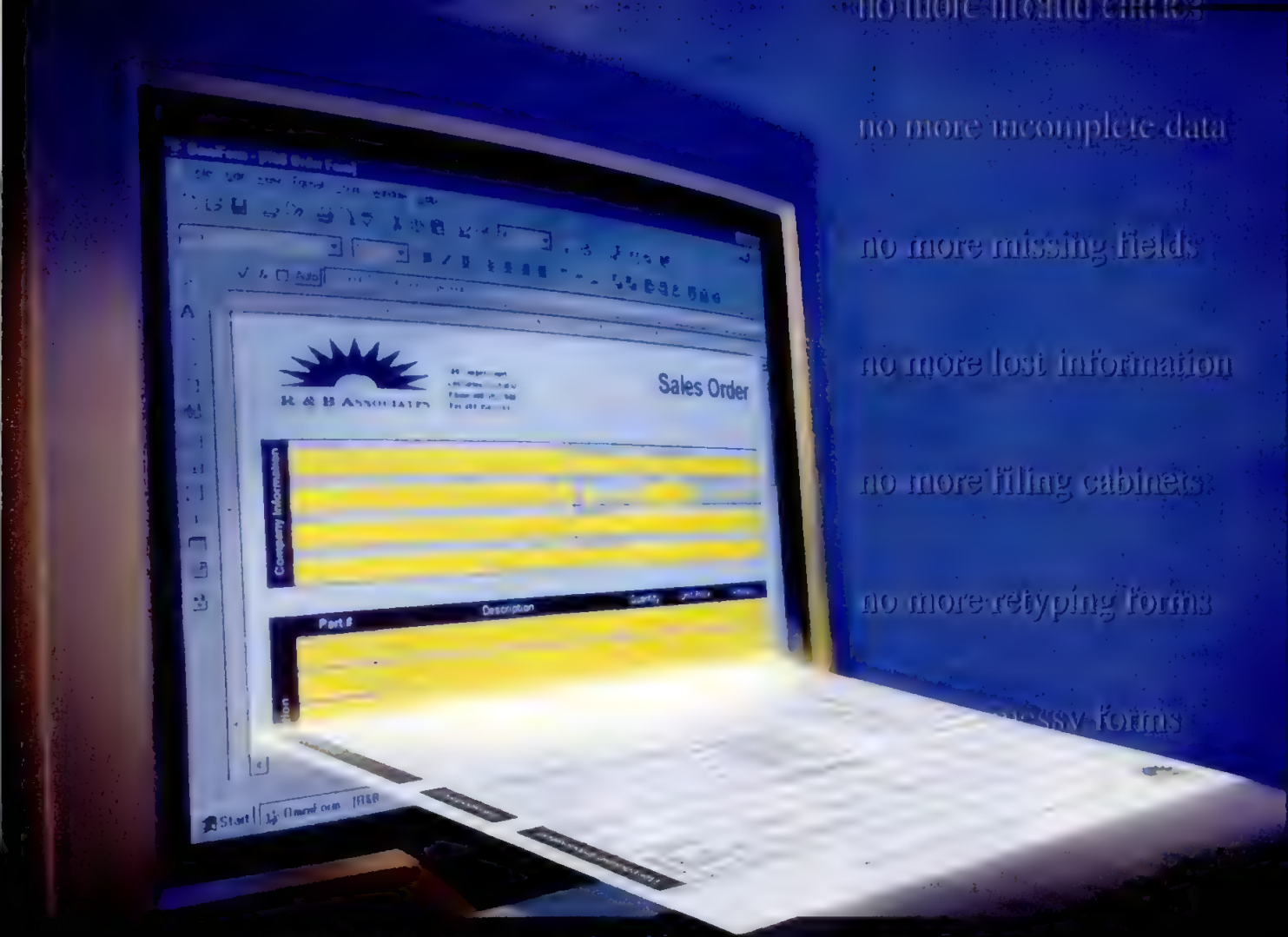

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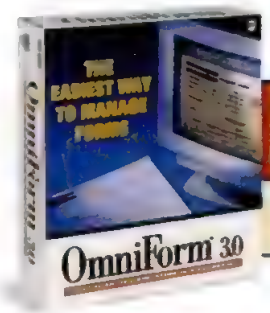

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Doing It *Your* Way

Christmas morning, around the tree. My 7-year-old got the Lego MindStorms robot kit. It was supposed to be for ages 11 and up, but what the heck; he's a smart kid. Exactly 11 minutes later, he was in his room building something with it. The result, trotted out an hour later, didn't look much like anything in the MindStorms manual—but his creation worked, and it was great.

There he was again, using something in ways it wasn't supposed to be used. Which, of course, we love.

I saw a lot of his dad in him that morning. Because for years, I've enjoyed taking products meant to be used for one thing and turning them around, to ends that are often just the opposite of—or simply unrelated to—what their creators intended.

Two good examples: the new Dragon NaturallySpeaking Mobile package, which adds to the company's best-of-breed speech recognition software a pocket-size, solid-state recorder (the NaturallyMobile), and Deja News, a Web site that tracks Usenet newsgroups.

Dragon's advertising for the NaturallySpeaking Mobile package makes clear the company's intention: This kit will let users break the bonds that tie them to their PCs when using Dragon NaturallySpeaking. You stick the recorder in your pocket, dictate wherever you go, dump your dictation into the PC, and process it into Microsoft Word 97 files back at your desk.

Fair enough. The NaturallyMobile works fine that way. And the product is a logical line extension for Dragon, which beefed up its offerings in the fourth quarter of 1998 with several new titles, perhaps partly in anticipation of its planned initial public stock offering in the first quarter of 1999.

For me, that sounds like a clever way to extend a product I've used with great success. I put on that crummy little headset with the awkward boom mike, wiggle it all around a little, and go. The results are never perfect, but they're faster and more accurate than my typing. Someday it will be more accurate, but NaturallySpeaking's better than good enough today—which is, well, good enough for me.

But boy, I hate that little headset, though it's essential for satisfactory recognition accuracy. After all, the whole product's built around....

Wait a minute! Why not lose the dumpy headset and boom mike permanently and instead just sit back in my desk chair, put my feet up beside my keyboard, and dictate into the little NaturallyMobile recorder? I could then dump my dictation into the PC and let NaturallySpeaking process it, and *bingo*, I'd have Word 97 files ready for cleanup. This adds a step (manually transferring the WAV file to the PC) but is easy enough with Dragon's simple Voice-It Link software.

This idea sounded good, so I tried it. And I've continued using it, since about two days after I got my hands on the NaturallyMobile recorder.

Dragon admits privately that recognition accuracy may suffer a little when you use the NaturallyMobile recorder instead of the headset. Perhaps: When I've run recognition-accuracy tests, files created with the recorder were maybe 1 or 2 percent less accurate than with the headset. (Probably because optimum recognition accuracy depends on keeping an absolutely constant lips-to-microphone distance, but I tend to wave the NaturallyMobile recorder around a little when I use it.)

I practically never carry the little NaturallyMobile recorder around with me to record things away from my desk. Maybe in time I will, but not now. For me, the purposive isolation of disappearing into my office, closing the door, and sitting down at my desk is essential to concentrating on my writing. But the recorder sure has made using NaturallySpeaking a lot more comfortable and convenient.

Even though I'm not using the product the way Dragon intended.

On to Deja News. I'm not a huge fan of newsgroups: There's lots of dross, little gold. And my e-mailboxes are already full, so I don't want anything sent directly to me, and I avoid getting on group lists. But there is useful stuff buried in newsgroups—stuff I need. So for years I've semipatiently gone in with my news reader du jour and trolled through the newsgroups I find useful. Tedious but often worthwhile.

When Deja News appeared, I marveled at what a stupid idea it was: a newsgroup *archive*, for gosh sake.

Deja News makes the notion of using a news reader, and spending the time to crawl through newsgroups, thoroughly obsolete.

More on the Web:
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Jim Seymour

Who'd want to keep all that blather? When friends who were thinking about investing in Deja News early on asked me what I thought of it as an investment, I patiently explained to them what a zoo newsgroups were, and how the Web, push technology, and the rest were going to bury newsgroups and any company based on archiving them. Bad idea, I assured them.

My friends ignored me, to their substantial gain: A couple of nice venture-capital rounds later, Deja News is flourishing, thank you very much, and is worth many times more than it was when I counseled against investing in it. Duh.

Finally, about six months ago, it hit me that the real value of Deja News, for a user, wasn't the ability to go in and look up old newsgroup postings but the fact that Deja News makes the notion of using a news reader, and spending the time to crawl through newsgroups on a daily or weekly schedule, thoroughly obsolete.

Because with Deja (as its users call it), you can just drop in any time you want, do a nice familiar Web-style search, and find anything and everything that has appeared on what interests you. No more coping with Harleys for sale in *alt.commerce.computers* or those recipes for cookies in *alt.barney.dinosaur.die.die.*

Now I'm back where I was with newsgroups a few years ago—which I count as a good thing. I don't have to waste a lot of time, but I find what I need.

Thanks to Deja News. And thanks to my ignoring Deja News' notion that I should use it as a formal archive to go back and find old postings, and instead using it as a current-events finder. Or something like that.

I heartily recommend finding your own ways to use PC products. In my experience, the more your actual use diverges from a product's intended use, the more important the product's going to become to you.

Send me a note (*jim_seymour@zd.com*) with your favorite "misuses" of computer products, and I promise to revisit this notion in another column soon. Maybe we will start our own Usenet group: *alt.computers.intentional.misuse.barney.die.* PC

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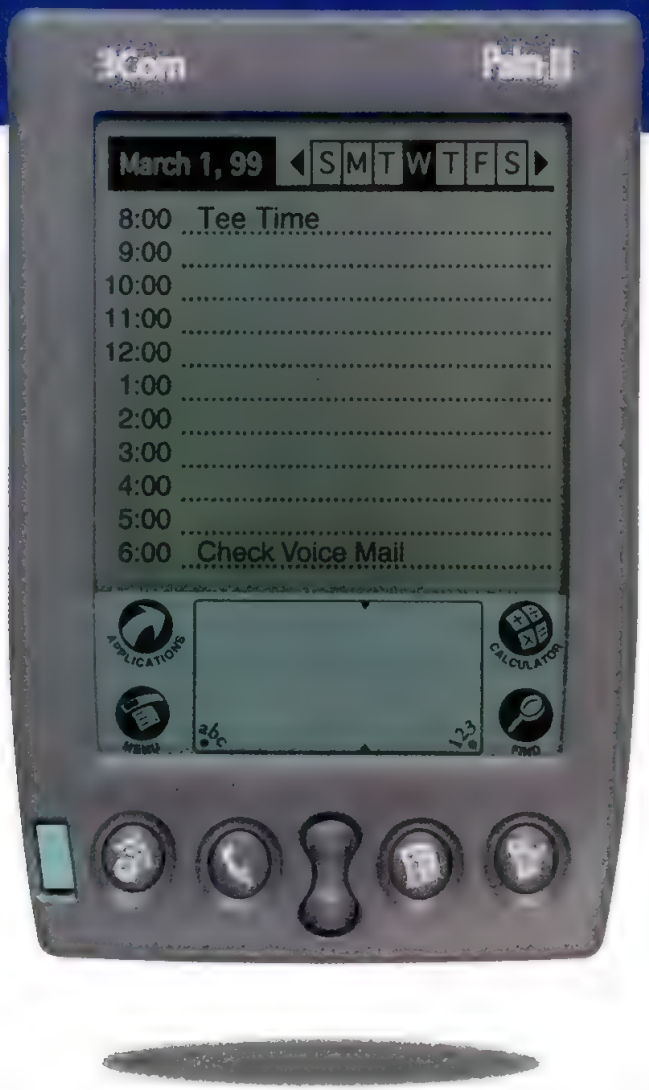

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Travel Connections

Now that I've placed a second bed pillow on the seat of my hotel room's only movable chair, it's almost high enough to allow for a passable (if wobbly) typing position, so I can work at the only table that resembles a desk. Such is the lot of the road warrior. Life on the run is never as productive or comfortable as it appears in commercials. Here's a checklist—make that a wish list—of what would make life better for the traveling businessperson.

First, the ideal hotel room would have a computer desk (about 26 inches high), not just a writing desk (30 inches high), with an ergonomic chair. On the wall at desk height, there'd be a four-port electrical outlet. And the electrical jack for the desk lamp that you switch off near the door would be marked as such, so you wouldn't inadvertently plug your recharging notebook into it. The room would have a two-line phone so that line 2 could be dialed directly from the outside; you'd have modem jacks on the phone by the bed and even the phone in the bathroom. There'd be a combination printer/fax machine on the desk. And you'd have a safe in the closet big enough for your notebook and camera.

The room would have an Ethernet connection, so you could link back to your office or surf the Web at serious speeds. In-room Ethernet has already come to a handful of hotels, and the $7- to $10-per-day surcharge isn't bad compared with getting nicked 75 cents a call for 800-service access. This would also be a great addition to airport club rooms, though the Red Carpet club at SFO and the Crown Room at Atlanta are already overcrowded.

Life for the long-distance road warrior would get better if airlines either improved their luggage-handling service so your bags would get to the carousel before you do (this happens regularly at Southwest) or added more on-board storage-bin space (Continental is working on that). On the occasions when I've upgraded, I've found that on an increasing number of planes there's no under-seat storage: The space is taken up by the electronics for the expanded entertainment system. Having 21 channels of digital audio and half a dozen simultaneous movies on a Boeing 777 is cool, but I'd trade that in a minute for more storage space. I believe an airline is cheating you in the seat-pitch department when you upgrade to business or first class and the reclining seatback of the passenger in front whacks the lid of your notebook. In coach, of course, that's a given.

Over the years, I've developed a couple of strategies that make life on the road more bearable. Noise-canceling headphones ($100 to $200) drown out jet engine noise even when you're in seat 32F, 2 feet from the engine. Multiple short and long phone cables with in-line couplers let you use your notebook anywhere in the hotel room; brightly colored cables make forgetting them less likely when you check out. I give my transformers address tags to improve the odds of getting them back if I forget them. The CD-ROM drive in my computer provides background music when I'm working; my next notebook will have DVD so I can watch movies on the road, too. Digital cellular phones with paging and voice mail have battery lives measured in days, not hours, and the sound quality is finally passable. Cell phones now handily undercut hotel long-distance pricing. And you can transfer data over cell phones, if you're patient.

I always carry a second battery for the computer. And I keep a second transformer ($50 to $100) available, so if I forget to pack one, I can call either home or the office and get the other overnighted to me. I carry a digital-phone-line tester (about $30) to make sure a line is safe for the modem. This is seldom a problem in hotels now, because most phones have modem jacks on the side (tip: *Any* hotel phone, digital or analog, is safe for your computer if you use the modem jack on the side). But when you're visiting a company, nobody seems to know which jacks are safe; even if the label on the jack says "modem," the connection may have been altered. In the car, I keep an AC inverter (12 volts stepped up to 120 volts) to power any notebook. I also have an in-flight power adapter (about $100) that works on a few planes and in all cars, because it also has a 12-volt lighter-socket plug.

Two drawbacks to this Boy Scout approach to preparedness: Although your notebook PC still weighs 5 pounds, the bag tops 15. And occasionally, you'll give the drowsy folks at airport security a start when the X-ray screen shows all those wires and solid objects in your bag. Who says travel can't be exciting? PC

Over the years, I've developed a couple of strategies that make life on the road more bearable.

More on the Web:

Bill Howard carries a 5-pound notebook, so why does his bag weigh 15 pounds? Check out his road warriors' guide.

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The Ultimate Upgrade Guide

PG. 156

SOUND CARDS

- Cost: $50 to $200
- Difficulty: Reasonable
- Gives you better 3-D and four-channel sound

PG. 172

MODEM

- Cost: $75 to $200
- Difficulty: Simple
- Increases connection speed twofold or more, if ISDN, cable modems, or ADSL connections available

PG. 136

GRAPHICS CARDS

- Cost: $75 to $200
- Difficulty: Reasonable
- Can triple 3-D performance

PG. 106

MEMORY

- Cost: $40 to $160
- Difficulty: Simple
- Easy way to get 20 percent performance boost (or more)

PG. 128

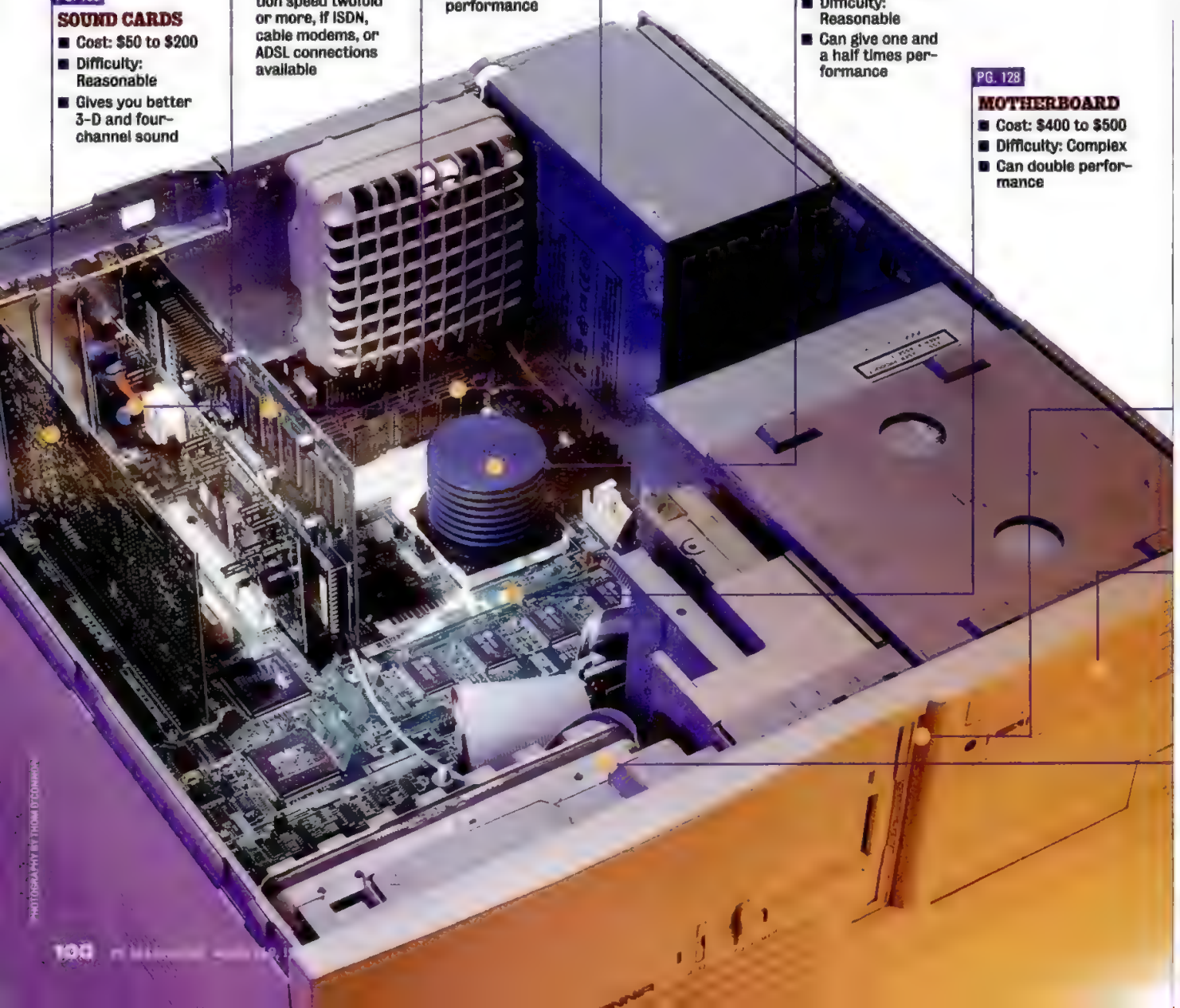
CPU

- Cost: $200 to $300
- Difficulty: Reasonable
- Can give one and a half times performance

PG. 128

MOTHERBOARD

- Cost: $400 to $500
- Difficulty: Complex
- Can double performance



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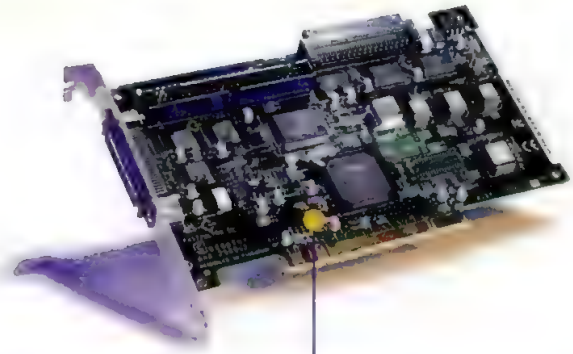


PG. 182

USB OR SCSI INTERFACE CARD

- Cost: $40, $400
- Difficulty: Reasonable
- Attach more or faster peripherals, with latest technology

PG. 143

MONITORS

- Cost: $300 to $1,000
- Difficulty: Simple
- Larger viewing area, or better, brighter picture with LCD

PG. 163

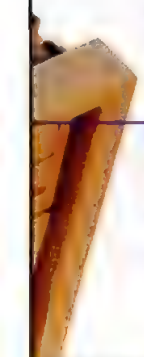
SPEAKERS

- Cost: $100 to $200
- Difficulty: Simple
- Enhance listening experience with four-channel sound and subwoofers

PG. 170

FLOPPY DISK DRIVES

- Cost: $75 to $150
- Difficulty: Reasonable
- Provide higher-capacity removable storage



PG. 168

CD-ROM DRIVES

- Cost: $250 to $500
- Difficulty: Reasonable (requires card and drive change)
- Get better multimedia and, with DVD-RAM, alternative removable storage

PG. 132

HARD DISKS

- Cost: $200 to $400
- Difficulty: Reasonable
- Triple storage capacity (or better) and get 10 percent overall performance boost

Should you upgrade some parts of your old system or buy new? That's the question many of us are facing today. In "The Most Cost-Effective Upgrades," the first section of our Ultimate Upgrade Guide, PC Magazine Labs tests memory, processor, motherboard, graphics, and hard disk upgrades and compares them with three new systems to see which—if any—upgrades are worth your time and money. In the section that follows, we test and review over 55 components—including multiple motherboards, DVD drives, sound cards, communications devices, and more—to find the best products for your upgrade needs.

Contents:

- **Upgrade Your Base System** **102**
- **Should You Upgrade or Buy New?** **106**
- **Pinpoint Your Best Upgrade** **108**
- **Upgrade Test Results** **118**

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Please join us online for more detailed results and test information on the many upgrade options tested in this story as well as individual product reviews.

THE MOST COST-EFFECTIVE UPGRADES

By Alfred Poor

Who among us hasn't looked upon shiny new systems with longing, then turned back to work on a computer that is more than a few generations behind the leading edge? For a modest investment, you can breathe new life into your existing system, avoid the hassles of converting to a new computer, and extend your original investment a few more years.

Sounds great, right? But the big question is which upgrades are worth the money, especially considering that new PC prices are as low as $400 to $500.

To answer this question, you must examine the components in your existing system, the applications you use most often, and your budget. You should also consider how much technical support you need and the value of your time. Each upgrade takes anywhere from 15 minutes to 1 hour, and you may have to spend even more time troubleshooting the new part. There is satisfaction to be gained from doing the job yourself, and you will learn a lot in the process, but it will cost you.

To help you decide which upgrades make sense for your needs, PC Labs took two older systems—one 200-MHz Pentium system and one 233-MHz Pentium II—and performed a variety of hardware upgrades on each of them. We then ran our suite of benchmark tests on several upgrade combinations, comparing the results with the original system and evaluating the time and money spent for each upgrade. We also compared these upgrades with the price and performance of three new systems, one each from Compaq, IBM, and Gateway, to see when it makes sense to upgrade and when it makes sense to buy a new system.

WHEN DOES IT PAY OFF?

We found that if you're starting with a Pentium/200 system, you can breathe new life into your PC without spending more than $600, and often much less than that. A memory upgrade is still the most effective way to increase your general performance, and it will cost you less than $100. The least expensive new PCs—those at about $600—offer only minimal performance gains; their hardware is often only little better than our Pentium/200.

The new systems in the $900 range offer about 35 to 40 percent better performance than our Pentium/200 system. But that's not all: You get a new warranty covering all parts, a single point of contact in case of trouble, generally bet-

Upgrade Your Pentium/200 Base System

Don't despair: For $500 to $700, you can still do a lot with your Pentium system. Try a memory upgrade first for $40.

$100 OR LESS

IMPROVE PERFORMANCE
Upgrade memory to 64MB ($40).

ENHANCE MULTIMEDIA
Upgrade memory to 64MB ($40).

IMPROVE 3-D
Not feasible at this price.

INCREASE STORAGE
Add a 100MB Iomega Zip Drive ($80) or a SuperDisk LS-120 drive ($90).

$250 OR LESS

IMPROVE PERFORMANCE
Upgrade memory to 64MB ($40) or 128MB ($160).

ENHANCE MULTIMEDIA
Buy a new sound card and a new graphics card ($250), or consider a DVD upgrade kit ($250).

IMPROVE 3-D
Buy a new graphics card with 3-D support and 16MB of RAM ($150)

INCREASE STORAGE
Add a 250MB Zip Drive ($200), or a fast, 7,200-rpm 6.5GB hard disk ($200).

$500 OR LESS

IMPROVE PERFORMANCE
Upgrade the CPU to an AMD K6-2/400, and upgrade memory to 64MB ($290).

ENHANCE MULTIMEDIA
Buy a 17-inch monitor, a new sound card, and speakers ($500), or consider a DVD upgrade kit, a new sound card, and speakers ($450).

IMPROVE 3-D
Upgrade the CPU to an AMD K6-2/400, increase memory to 64MB, and buy a new graphics card ($440), or consider a 17-inch monitor ($300).

INCREASE STORAGE
Add a 5,400-rpm 17.2GB hard disk ($350) or 7,200-rpm 14.4GB hard disk ($390), or consider a 2GB Jaz Drive ($380) or a CD-RW drive ($300).

$1,000 OR LESS

IMPROVE PERFORMANCE
Upgrade to a Pentium II/400 motherboard (with 128MB RAM, $680; with 64MB RAM, a new graphics card, and a 6.5GB hard disk, $940), or buy a new Pentium II, Celeron, or AMD K6-2 system.

ENHANCE MULTIMEDIA
Buy a new Pentium II, Celeron, or AMD K6-2 system.

IMPROVE 3-D
Buy a new Pentium II, Celeron, or AMD K6-2 system.

INCREASE STORAGE
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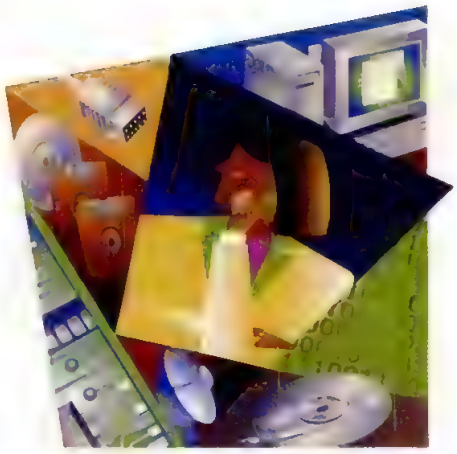
ter hardware, and (often) new software. Spend $1,950 on a Pentium II/400 system with 128MB of RAM, a 12GB hard disk, and an 8MB graphics card and you'll get almost double the performance.

If you have at least a Pentium II/233 PC, consider only targeted upgrades. Faster Internet connections or better 3-D graphics performance can be had for under $200. Here, the new PCs in the $900 range offer few performance benefits, but a new Pentium II/400 system—at $1,950—offers about 55 percent better performance.

Some upgrades have nothing to do with quantifiable performance. You may be looking for better viewing quality from your monitor, a bigger monitor, or a larger hard disk. Or you may want a DVD-ROM drive so that you can enjoy the latest games, movie, and edutainment. Once you decide on an upgrade, read the product reviews in the following sections: Core Components, Multimedia, and Internet I/O.

A memory upgrade is still the most effective way to increase your general performance, and it's inexpensive—costing less than $100.



OUR PLATFORMS

We started with two fairly typical systems: a Pentium/200 and a Pentium II/233 with 3-D graphics support. We relied on the ZD Winstone benchmark test suite to gauge general performance on business applications and used the WinBench 99 tests to look at gains in specific subsystems. In addition, we used the new CPUmark 99 test to evaluate CPU and memory subsystem performance.

We then tested the performance with certain upgrade components installed both separately and in combination. We added memory, larger and faster hard disks, fast 3-D graphics adapters, and (for the Pentium/200) a new, faster CPU. We even replaced the entire motherboard and processor to turn the Pentium/200 system into a fire-breathing Pentium II/400 PC.

Now, you can't reduce these results to simple numbers, because in some cases there are advantages beyond just the performance increase. But we did perform a calculation that lets you compare the results on a quantitative level. We divided the percentage of performance improve-

Upgrade Your Pentium II Base System

If you have a Pentium II, even a low-end model, don't bother with bargain-priced PCs. Either save your money for a new system next year, or invest in some targeted upgrades of $500 or less.

$100 OR LESS

IMPROVE PERFORMANCE

Upgrade memory to 128MB ($80).

ENHANCE MULTIMEDIA

Buy a new sound card ($100).

IMPROVE 3-D

Not feasible at this price.

INCREASE STORAGE

Add a 100MB Iomega Zip Drive ($80) or a SuperDisk LS-120 drive ($90).

$250 OR LESS

IMPROVE PERFORMANCE

Upgrade memory to 128MB ($80).

ENHANCE MULTIMEDIA

Buy a new sound card and a new graphics card ($250), or consider a DVD upgrade kit ($250).

IMPROVE 3-D

Buy a new graphics card with 3-D support and 16MB of RAM ($150).

INCREASE STORAGE

Add a 250MB Zip Drive ($200) or a fast, 7,200-rpm 6.5GB hard disk ($200).

$500 OR LESS

IMPROVE PERFORMANCE

Upgrade memory to 128MB; add a fast, 7200-rpm 6.5GB hard disk and a new graphics card ($430).

ENHANCE MULTIMEDIA

Buy a 17-inch monitor, a new sound card, and speakers ($500), or consider a DVD upgrade kit, a new sound card, and speakers ($450).

IMPROVE 3-D

Buy a 17-inch monitor and a new graphics card ($450).

INCREASE STORAGE

Add a 5,400-rpm 17.2GB hard disk ($350) or 7,200-rpm 14.4GB hard disk ($390), or consider a 2GB Jaz Drive ($380) or a DVD-RAM drive ($500).

$1,000 OR LESS

IMPROVE PERFORMANCE

Stop at $500, or save your money for a new system later.

ENHANCE MULTIMEDIA

Buy a 17-inch monitor, a new sound card, speakers, and a DVD upgrade kit ($750).

IMPROVE 3-D

Stop at $500, or save your money for a new system later.

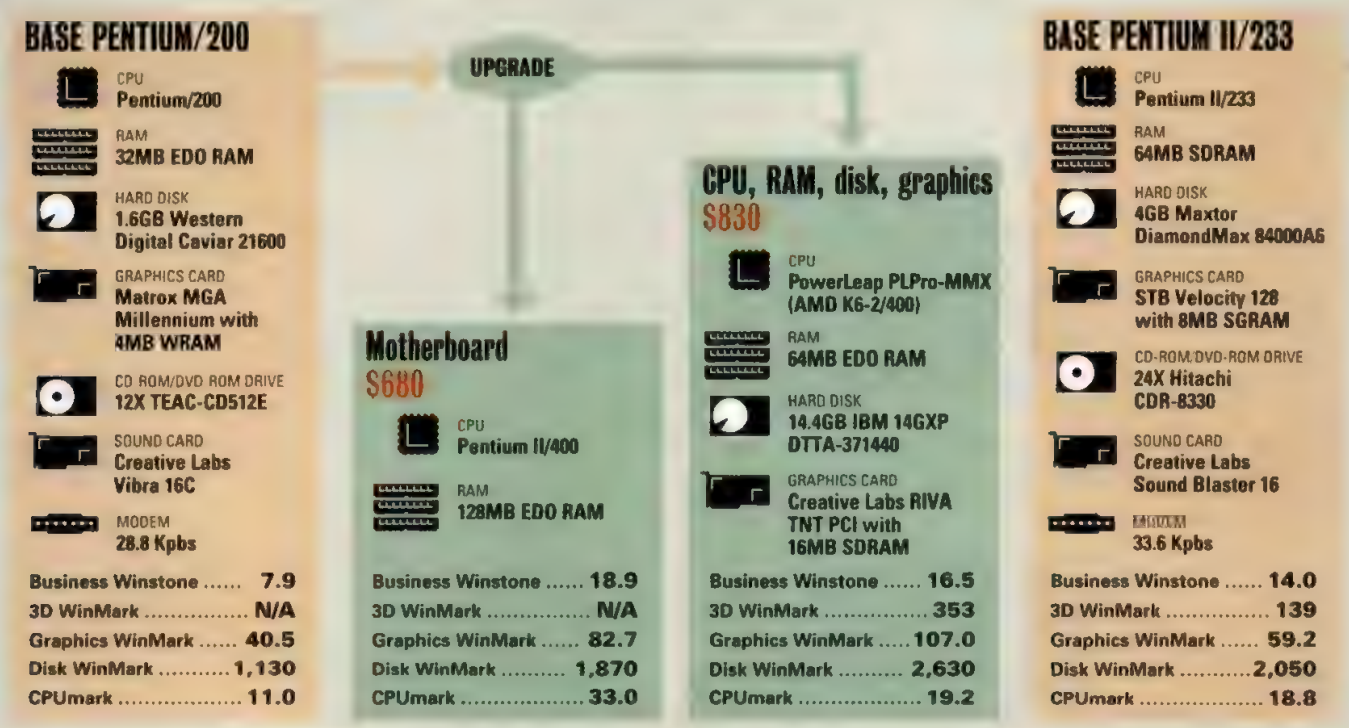
INCREASE STORAGE

Stop at $500, or save your money for a new system later.

ILLUSTRATIONS BY DENNIS HARMES

Should You Upgrade or Buy New?

UPGRADE? In almost every case, if you upgrade, you'll end up with better performance and better hardware. But you do miss out on new warranties and special programs that offer benefits beyond the traditional parts-and-labor service. (IBM's Owner Privileges, for example, include preferred call handling, e-mail tips, upgrade advisory information, and a member-only toll-free number.) You'll also have to deal with all the troubleshooting problems on your own—which may add up to a significant drain on time and money. Upgrades make a lot of sense for a Pentium II owner looking to extend the life of the system. Targeted upgrades, such as a new powerful graphics card or more memory, will improve performance where you need it, without the problems of a major upgrade or the cost of a new unit.



N/A—Not applicable. The unit's graphics card could not complete this test

ment by the dollar cost of the upgrade used to get those gains. Again, for a Pentium/200, the single most cost-effective upgrade you can make is to increase the memory from 32MB to 64MB. Nothing else comes close. And for the Pentium II, aside from increasing 3-D graphics performance via a new graphics adapter, none of the upgrades gave significant gains on the basis of a percent increase per dollar spent.

PENTIUM 200 UPGRADES

Our base Pentium/200 unit had 32MB of memory, 512K of L2 cache, a Western Digital Caviar 21600 1.6GB hard disk, and a Matrox Millennium graphics adapter with 4MB of WRAM. Its performance was just over half that of some of today's mainstream PCs but still better than that of our lowest-cost system—the $599 Compaq Presario 2289, a Cyrix M2/333 unit. (The Compaq's poor performance is caused, in part, by its motherboard chip set, the SiS 5590, and its integrated graphics controller, which takes 4MB of system memory for use as graphics memory.)

The first upgrade we performed was a memory increase. Simply adding 32MB more RAM to this system gave a just over 20 percent boost in the Business Winstone score. And figuring the pair of 16MB EDO SIMMs at $20 apiece (the price when this story was written) amounts to a 0.5 percent increase per dollar. This also gave a 16 percent boost to the Disk WinMark 99 score—for a 0.4 percent per dollar gain. You'll really notice the decreased disk swapping, which gives you faster access to applications and files you have open and lets you run more applications concurrently. Memory upgrades are also easy to perform, taking less than 15 minutes.

"Nothing succeeds like excess" wrote Oscar Wilde, so we poured on the memory. You must replace your original RAM in order to get to 128MB, so the total tab for that upgrade is $160 (four 32MB SIMMs). Counterintuitively, we saw the Winstone score decrease a bit from the levels of the 64MB score. We suspect that's related to the unit's 430HX chip set. With the proper yet more expensive 16K X 11-bit tagRAM, HX chip sets take full advantage of 128MB of RAM by caching above the 64MB memory space; with the less expensive and more common 16K X 8-bit tagRAM, they do not. As a result, adding memory to this level gave only a 0.11-percent-per-dollar return on the Winstone score. You will still see benefit from the RAM, thanks to decreased disk swapping.

Our Contributors: ALFRED POOR is a contributing editor of *PC Magazine*. RICH FISCO was the senior project leader, and ANUSH YEGYAZARIAN was the associate editor in charge of this story.

BUY NEW? If your current PC is less powerful than a Pentium/200, then a value-priced system makes the most sense. A new unit offers you a complete warranty, one point of contact, new software, and new system technology—without potential upgrade problems. Those on tight budgets should consider sub-$600 systems. Everyone else should spend more or do targeted upgrades. A $900-plus system will be a decent long-term value, and the price is terrific. Make sure to get at least 48MB of memory: It'll give you better performance and help you avoid upgrading your system in the near future.

UPGRADE

RAM, disk, graphics
$540

- RAM: 128MB SDRAM
- HARD DISK: 14.4GB IBM 14GXP DTTA-371440
- GRAPHICS CARD: Creative Labs RIVA TNT PCI 16MB SDRAM

Business Winstone	16.0
3D WinMark	357
Graphics WinMark	92.0
Disk WinMark	2,620
CPUmark	18.8

COMPAQ PRESARIO 2289
$599 (direct)

- CPU: Cyrix M2/333
- RAM: 32MB SDRAM
- HARD DISK: 4.3GB Seagate ST34323A
- GRAPHICS CARD: Integrated SiS 5598
- CD-ROM/DVD-ROM DRIVE: 24X LiteOn LTN-301
- SOUND CARD: Integrated Ensoniq ES1869
- MODEM: 56 Kbps

Business Winstone	6.6
3D WinMark	N/A
Graphics WinMark	33.6
Disk WinMark	902
CPUmark	17.5

IBM E2U
$899 (direct)

- CPU: AMD K6-2/333
- RAM: 48MB SDRAM
- HARD DISK: 6GB Quantum Bigfoot TX
- GRAPHICS CARD: Integrated ATI Rage Pro Turbo AGP with 4MB SGRAM
- CD-ROM/DVD-ROM DRIVE: 24X Acer 632A
- SOUND CARD: Integrated Crystal CS-4235 KQ
- MODEM: 56 Kbps

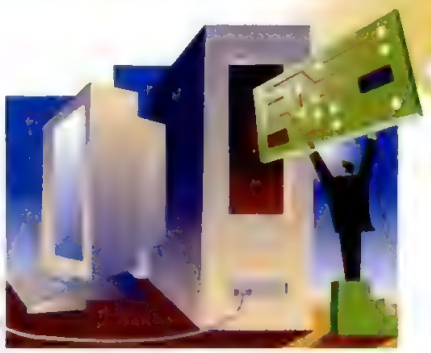
Business Winstone	11.1
3D WinMark	132
Graphics WinMark	65.6
Disk WinMark	1,320
CPUmark	23.4

GATEWAY G6-366C
$969 (direct)

- CPU: Celeron/366
- RAM: 32MB SDRAM
- HARD DISK: 3.2GB Western Digital Caviar AC13200
- GRAPHICS CARD: Integrated ATI Rage Pro Turbo AGP with 4MB SGRAM
- CD-ROM/DVD-ROM DRIVE: 4X Hitachi GD-2500 DVD
- SOUND CARD: Integrated Creative Labs Ensoniq AudioPCI
- MODEM: 56 Kbps

Business Winstone	10.7
3D WinMark	160
Graphics WinMark	67.0
Disk WinMark	1,446
CPUmark	28.8

What about a faster hard disk? Returning to the 32MB memory configuration, we tried both a Maxtor DiamondMax 91728D8 disk with 17.6GB capacity (about $350 at the current street price) and an IBM 146XP DTTA-371440 disk drive with 14.4GB capacity at a $390 street price.



Both resulted in noticeable increases in the Business Winstone scores (12 and 14 percent, respectively), but the big gains were in the Business Disk WinMark results. The IBM increased the score by 53 percent, and the Maxtor pushed data through 48 percent faster than the base system. Even this level of gain doesn't give you much on a per-dollar analysis, but the true value of these upgrades isn't in performance: They represent a 9- to nearly 11-fold increase in storage capacity. What this extra capacity is worth to you is an individual matter, depending on how much space you have left on your original hard disk and whether you work with large files, such as those in graphics-editing applications.

If your BIOS has a hard-disk size limit that's larger than your new disk, installation and data transfer should be a breeze.

Hard disk upgrades used to be far more difficult, because you had to back up and transfer both the data and the operating system piecemeal. Today's hard disks come with software utilities that make these transfers a breeze. Installing the hardware and transferring your data should take about 45 minutes. But if your existing system's BIOS has a hard disk size limit smaller than your new disk, as our base system did, you'll have to install special overlay software that usually comes as part of the upgrade package. Unfortunately, the software does not walk you through an easy install, making the whole process difficult and time-consuming.

Next, we upgraded the graphics

Pinpoint Your Best Upgrade

If your system's performance is satisfactory in most respects but one or two applications feel as if they're running in cement shoes, chances are that an upgrade will give your older system a new lease on life and keep you happy with its performance for a few more years.

Slow Internet access.
Most likely it's your connection, not your system. Upgrade to a 56K modem (if your ISP and phone lines support it). For even faster connections, look into ISDN, cable modem, or ADSL connections if they are available in your area (see "Fast Connections" in the Internet and I/O section of this story).

Excessive swap file activity.
If your disk thrashes about when you're working with large files or more than one application at a time, add memory. It would benefit you to have at least 256K of secondary processor cache to go along with it.

Slow graphics performance.
First, run at the lowest resolution and color depth that are sufficient for your needs. Unless you're working with photographs, 256 color will probably look just as good as 24-bit color and will put one-third the load on your graphics adapter. If this doesn't help, consider a graphics adapter upgrade with a more powerful accelerator on-board. If you want better 3-D performance, the only way to get it is through hardware (see "Graphics Accelerators" in the Multimedia section of this story). Also check your system or graphics vendor's Web site for the latest drivers available for your board: Newer drivers typically fix minor bugs and are better optimized, providing faster performance.

Running out of storage space.
The simple solution is to buy another hard disk; prices have never been lower. The decision here is whether to go for more capacity in a 5,400-rpm drive or slightly less in a faster, 7,200-rpm drive (see "Hard Disks" in the Core Components section of this story). But consider upgrades that solve more than one problem and cost about the same: For example, a DVD-RAM upgrade gives you 2.6GB of removable storage per cartridge side, and dual-sided cartridges cost about $35—less than a penny per megabyte. While not as fast as a hard disk, they can hold the programs and data that you don't use very often, handle backup tasks, and provide access to CD and DVD media (see "DVD Drives" in the Multimedia section).

Too many parallel devices.
Parallel ports aren't just for printers any more; now CD-ROM drives, scanners, and other devices plug into parallel ports. Unfortunately, they don't always get along when trying to share a port. A second parallel port can cost less than $20 and is easy to install in any available slot. Or consider getting a SCSI adapter and replacing the nonprinting peripherals with SCSI versions; you'll get better performance with fewer conflicts (see "Interfaces" in the Internet and I/O section).

All of the above.
If your system is getting too small and too slow, consider a new unit instead of a major upgrade. Not only will you have a single warranty covering the entire system—which makes fixing it easier if something goes wrong—but you'll also have your old unit, which you can network to the new one as a file or print server.—*Alfred Poor*

adapter, which took about 15 to 20 minutes. The PCI Creative Labs Graphics Blaster, based on the nVidia RIVA TNT chip, provided an increase in 3-D graphics performance, because the base model's Matrox Millennium card didn't support the 3-D graphics features used by our 3D Winbench test. The new card also boosted the standard Business Graphics WinMark score by about 30 percent. When you factor in the $150 street price of the new card, this yields a 0.2-percent-per-dollar gain on the Graphics WinMark results—not bad.

As might be expected, combining all three upgrades—memory to 128MB, IBM hard disk, and 3-D graphics card, for a total cost of $695—boosted performance by 30 percent to the level of our new $969 Gateway G6-366C, a Celeron 366-based unit. In percent-per-dollar terms, however, the return was modest—just 0.04 with Winstone. You are saving close to $300 over the new system, but the drawbacks include no new warranty, a slower modem, no USB or AGP technology, and in the case of the Gateway, you also miss out on a DVD drive. But you have four times the memory, a graphics card about twice as fast, and a hard disk over 10GB larger.

BRAIN TRANSPLANT

Next on the list of upgrades was a new CPU. There are many such products available on the market, most of which are based on AMD and Cyrix CPUs. We were unable to get Evergreen and Kingston models in time for our testing. Evergreen's Spectra 333 ($250) and Kingston's K6-2/233-based and K6-2/333-based products ($300 and $350, respectively) should now be available.

We were able to test the new $250 PL-Pro MMX-400 from PowerLeap (*www.powerleap.com*, 877-278-5327), which uses an AMD K6-2/400 processor and comes with all the system clock and voltage changes that this chip requires, whether or not your existing motherboard provides such support. This fairly simple upgrade requires no more than 20 minutes.

As might be expected, the PowerLeap upgrade provided some increased speed, especially in the CPUmark 99 score. The gain on the CPUmark was 82 percent over the base configuration, and the Winstone score increased by over 30 percent. Given the modest price of the upgrade module,

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- ★ *Upgrade to 128MB 100MHz SDRAM, add $69.*
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$1599

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Network-Designed Desktop

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- 128KB Integrated L2 Cache
- 8.4GB Ultra ATA Hard Drive
- *NEW* 17" (16.0" viewable, .26dp) M780 Monitor
- 8MB ATI 3D AGP Graphics
- 32X Max^ Variable CD-ROM Drive
- Intel 10/100 Ethernet Controller
- ★ *3Com USRobotics V.90™ PCI Telephony WinModem, add $49.*
- ★ *Iomega Zip 100MB Internal Drive with Two Cartridges, add $99.*
- ★ *Upgrade to MS® Windows NT® Workstation 4.0, add $99.*

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POWER UPGRADES

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- In 1998, Dell Dimension desktops won more than 90 product and service awards. See www.dell.com/awards98 for details.
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- Three-time "A" rating in *PC Magazine*'s Readers' Choice Awards for Service and Reliability (1996-1998).
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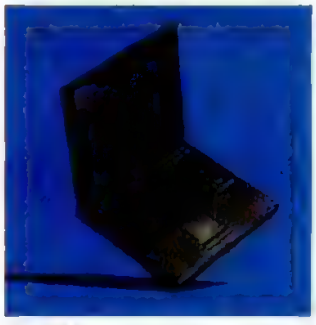

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- Removable Combo 24X Max^^ Variable CD-ROM and Floppy Drive
- 2X AGP 4MB ATI RAGE Pro 3D Video
- 3D Surround Sound
- 12-Cell Intelligent Lithium Ion Battery
- MS Office 97 SBE (Ask about Our *FREE* MS Office 2000 Upgrade Offer)
- Microsoft Windows 98/Touchpad
- 3-Year Limited Warranty[†]
- ★ *Upgrade to 96MB SDRAM, add $99.*
- ★ *Custom Leather Case, add $99.*
- ★ *Internal 56K Capable™ V.90 Modem, add $59.*

$2599

Business Lease[◇]: $98/Mo., 36 Mos.

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BENCHMARK TESTS

Upgrades

More RAM and a new CPU for the Pentium/200-based PC yielded the best performance boost for the money. For Pentium II PCs, upgrading RAM is a good idea, but a better 3-D graphics card made a bigger difference.

The **ZD Business Winstone 99** score is in many ways the most important measure when upgrading components. If a new component doesn't significantly improve general system performance as measured by the Winstone tests, you won't see the gain when using the PC. When seeking better performance, look to increase memory first. It's inexpensive, and going from 32MB to 64MB netted large gains, 20 percent for the Pentium/200 and 32 percent for the K6-2. Another upgrade that resulted in a big gain was the move from a Pentium/200 CPU to the K6-2/400. Although somewhat more costly, with 64MB of RAM this upgrade improved performance by 34 and 47 percent, depending on the CPU. Upgrading memory on the Pentium II/233 unit from 64MB to 128MB raised the Winstone score by a much more pedestrian 6 percent. Upgrading the motherboard gets you the most performance improvement. Our fully decked-out Pentium/200 scored less than half as well as the fully upgraded system with a Pentium II/400 motherboard.

The **ZD 3D WinMark 99** tests measure the graphics card's 3-D capabilities. The Matrox Millennium card in the base Pentium/200 was unable to run the test, because it could not support the necessary 3-D features, most notably MIP mapping, that are common in today's cards. Upgrading the graphics card yielded a respectable score. When we then upgraded the CPU from the Pentium/200 to the K6-2/400, the combination of the more powerful CPU and AMD's 3DNow! instruction set kicked the 3-D performance up by 67.3 percent over the graphics card alone. Substituting the new graphics card in the Pentium II/233 more than doubled that unit's 3-D WinMark score.

The final upgrade to a Pentium II/400 motherboard eked out the last bit of 3-D power, scoring about 32 percent better than the same configuration with the Pentium II/233.

The **ZD Business Graphics WinMark 99** suite tests 2-D graphics capabilities. Our testing shows that upgrading the CPU as well as changing the graphics card will give you better 2-D performance. Adding system memory proved to be of little help in 2-D performance. Upgrading to a K6-2/400 from a Pentium/200 increased performance by 60 percent. Changing the graphics card in the Pentium/200 upped performance by a third; on the Pentium II/400 motherboard, it yielded the biggest gain—85 percent.

The **ZD Business Disk WinMark 99** test focuses on the disk subsystem. For our upgrades, we chose a Maxtor DiamondMax 17.2GB drive and a similarly priced IBM Deskstar 14GXP 14.4GB drive. The Maxtor, a top-performing 5,400-rpm drive, kept pace with the 7,200-rpm IBM Deskstar, which would typically outperform a 5,400-rpm disk. In all similarly configured tests, however, the IBM and Maxtor were within 3 percent of each other. But the new drives scored about 50 percent better than the original 5,200-rpm drive in the Pentium/200 system, thanks mostly to their faster rotational speeds, and they were just over 30 percent faster than the older 5,400-rpm drive in the Pentium II/233. When we went from the 430HX-based Pentium/200 to the new 440BX-based motherboard, we gained Ultra DMA support, which gave the hard disks their biggest performance boost: 57.5 percent.

Our new **CPUmark 99** test measures the performance of the CPU, both L1 and L2 caches, and main memory. Except for changing the CPU, no other upgrades affect this score. When we upgraded the Pentium/200 system to an AMD K6-2/400 we saw a boost of about 80 percent. One interesting anomaly that we found was the result of the system's caching limitation above 64MB of memory. Though the Intel 430HX chip set can cache up to 512MB of memory, the motherboard needs to be using more expensive 16K-by-11–bit tag RAM to take advantage of this function. The Pentium II system did not use the more expensive tag RAM; thus, the performance actually went down by about 3 percent when we upgraded from 64MB to 128MB.

How We Tested

We tested a Pentium/200-based system and a Pentium II/233–based unit, both running Windows 98. We stripped each PC's start-up configuration of all processes and tasks except for Explorer and Systray, defragmented the hard disk before each test, and let Windows 98 manage virtual memory. We used the newest graphics drivers posted on the graphics card vendor's Web site. We ran all 2-D tests at 1,024-by-768 resolution, 32-bit color and 75-Hz refresh. We ran the 3D WinMark tests at 1,024-by-768 resolution, 16-bit color, and 85-Hz refresh, and triple-buffered if the card would allow.

The Pentium/200 system was a Micron Millennia desktop with a Micronics motherboard and the Intel 430HX chip set. We increased memory from 32MB to 64MB and 128MB, using 60-ns EDO DRAM SIMMs. We upgraded the original 1.6GB Western Digital Caviar 21600 hard disk (spinning at 5,200 rpm) to either a 17.2GB Maxtor DiamondMax 91728D8 (5,400 rpm) or a 14.4GB IBM DTTA-371440 (7,200 rpm). We also upgraded the graphics card from the original PCI Matrox MGA Millennium with 4MB WRAM to a PCI Creative Labs Graphics Blaster using the nVidia RIVA TNT chip set and 16MB of SDRAM. We upgraded the CPU using a PowerLeap PL-ProMMX chip based on a 400-MHz AMD K6-2. We installed the companion CPU Control Panel utility software for Windows and enabled the Write Allocate feature.

The Pentium II/233-based system was a Micron Millennia XKU tower with an Intel motherboard and Intel's 440LX chip set. We upgraded memory from 64MB to 128MB, using 66-MHz non-ECC SDRAM DIMMs. We started with a base Maxtor DiamondMax 84000A6 4GB, 5,400-rpm hard disk and upgraded to the IBM and Maxtor hard disks listed above. Our base graphics card was an AGP STB Velocity 128 based on the nVidia RIVA 128ZX chip set with 8MB of SGRAM; we upgraded to the AGP version of the aforementioned Graphics Blaster card.

For our motherboard upgrade, we used a SuperMicro P6SBA motherboard with Intel's 440BX chip set, a Pentium II/400 CPU and 128MB of PC 100 non-ECC SDRAM DIMMs. We started with the base hard disk and graphics card used in the Pentium/200 and upgraded to the IBM and Maxtor disks and the AGP version of the Creative Labs Graphics Blaster graphics card.

For more information on our benchmark test suites, please join us online at *www.pcmag.com.—Analysis written by Rich Fisco*

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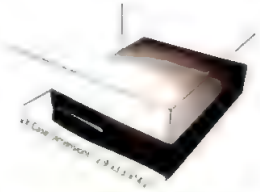

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Computer Buyers Guide and Handbook (Feb. 99)

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Equipped with the most powerful Intel® processors available, our Business Desktops give you built-in advanced management capabilities without sacrificing speed. Whether your business is at home or spread across the globe, the enterprise management technology integrated into our Business Desktops will add real value while lowering your total cost of ownership. Built according to industry-standard initiatives such as Wired for Management, DMI 2.0, PC98 and ACPI, these systems incorporate capabilities for improved asset management as well as remote configurations and diagnostics. Plus, our advanced QSentry Technology assures unsurpassed confidence and security at all times by constantly monitoring the health of your Quantex PCs. Why choose between the capacity your business needs and the speed you want, when you can have them both?

Windows® 2000 Ready PCs

Quantex's Windows 2000-Ready Business Desktops come installed with Windows NT Workstation 4.0 to protect your technology investment by providing an optimal upgrade path for future hardware advances and the highly anticipated Windows 2000 operating system

BUSINESS DESKTOPS

QP6/333 SB-1c $999

Business lease: $35/Mo. **Order Code #pcm0330**

- Intel® Celeron™ Processor 333MHz
- 32MB SDRAM Memory, 128KB Secondary Cache
- 4.1GB Ultra ATA HDD, 3.5" 1.44MB Floppy Drive
- 15" Digital Monitor (13.8" viewable)
- 8MB 3D AGP Graphics Card with 4MB SDRAM
- Intel PRO/100+ PCI Fast Ethernet Controller w/ RJ-45 and Wake On LAN Technology
- New 40x Max Variable Speed CD-ROM Drive
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Mouse
- MS Windows 98
- 3 year limited warranty with 1 year On Site Service*
- 24 hour, 7 days, Technical Support
- 2 Universal Serial Bus (USB) Ports - DMI 2.0
- QSentry Technology including Intel LANDesk Client Manager
- Cable Modem Ready - Year 2000 Compliant

QP6/400 SB-1c $1149

Order Code #pcm0331

Above system with 400MHz Intel® Pentium® II processor, 64MB SDRAM, 6.4GB

QP6/400 SB-2 $1499

Business lease: $53/Mo. **Order Code #pcm0332**

- Pentium® II processor 400MHz
- 64MB PC100 SDRAM Memory, 512KB Secondary Cache
- 8.4GB Ultra ATA HDD, 3.5" 1.44MB Floppy Drive
- 15" Digital Monitor (13.8" viewable)
- Intel 740 3D 2X AGP Graphics w/8MB SDRAM
- Intel PRO/100+ PCI Fast Ethernet Controller w/ RJ-45 and Wake On LAN Technology
- New 40x Max Variable Speed CD-ROM Drive
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Intellimouse
- MS Windows 98, Microsoft Office 97 SBE v2.0
- 3 year limited warranty with 1 year On Site Service*
- 24 hour, 7 days, Technical Support
- 2 Universal Serial Bus (USB) Ports - DMI 2.0
- QSentry Technology, including Intel LANDesk Client Manager
- Cable Modem Ready - Year 2000 Compliant
- Add Business Audio 4.1 speaker $79
- Upgrade to Windows NT 4.0 Workstation, add $99

QP6/350 SB-2(w/Pentium II processor 350MHz).....$1349

QP6/450 SB-3 $1899

Business lease: $67/Mo. **Order Code #pcm0333**

- Pentium® II processor 450MHz
- 128MB PC100 SDRAM Memory, 512KB Secondary Cache
- 8.4GB Ultra ATA HDD, 3.5" 1.44MB Floppy Drive
- 17" Monitor w/OSD & NEC OptiClear CRT (16.0" viewable, 1600x1200 resolution, 75dp
- Intel 740 3D 2X AGP Graphics w/8MB SDRAM
- Intel PRO/100+ PCI Fast Ethernet Controller w/ RJ-45 and Wake On LAN Technology
- New 40x Max Variable Speed CD-ROM Drive
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Intellimouse
- MS Windows NT Workstation 4.0
- Microsoft Office 97 SBE v2.0
- 3 year limited warranty with 1 year On Site Service*
- 24 hour, 7 days, Technical Support
- 2 Universal Serial Bus (USB) Ports - DMI 2.0
- QSentry Technology, including Intel LANDesk Client Manager
- Cable Modem Ready - Year 2000 Compliant - Windows 2000 Ready

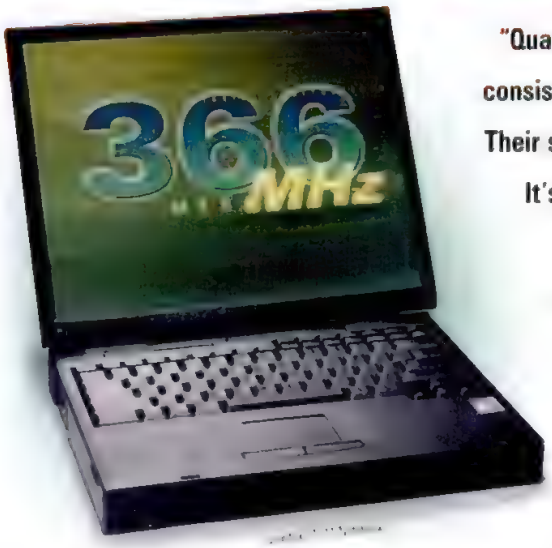
QP6/400 SB-3(w/Pentium II processor 400MHz).....$1699

QP6/450 SB-4 $2199

Business lease: $77/Mo. **Order Code #pcm0334**

- Pentium® II processor 450MHz
- 128MB PC100 SDRAM Memory, 512KB Secondary Cache
- 13GB Ultra ATA HDD, 3.5" 1.44MB Floppy Drive
- New 19" Monitor w/NEC OptiClear CRT (18.1" viewable, 1600x1200, 25dp
- New Ultra Fast 4-9 Revolution IV 128-bit 3D AGP Video w/32MB
- Intel PRO/100+ PCI Fast Ethernet Controller w/ RJ-45 and Wake On LAN Technology
- New 40x Max Variable Speed CD-ROM Drive
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Intellimouse
- MS Windows NT Workstation 4.0
- Microsoft Office 97 SBE v2.0
- 3 year limited warranty with 1 year On Site Service*
- 24 hour, 7 days, Technical Support
- 2 Universal Serial Bus (USB) Ports - DMI 2.0
- QSentry Technology, including Intel LANDesk Client Manager
- Cable Modem Ready - Year 2000 Compliant - Windows 2000 Ready
- Upgrade to Sony DVD-ROM Drive, add $249

your desktop? Or to go?



"Quantex desktops have continued to exceed our expectations by consistently delivering the latest technology at an outstanding value. Their sales and and tech support people are nothing short of superb. It's only natural - now that we're automating our sales force, we've chosen Quantex notebooks."

Brian Adair, Operations Manager, Dairyland USA Corp., Bronx, NY.

The Quantex I-1511 Notebook—complete with the awesome power of Intel's latest mobile Pentium® II processor 366MHz, an "XX-Large" 15" Active Matrix Display, powerful 128MB of SDRAM, massive 8GB hard drive and sharp ATI 3D AGP Video w/8MB—for the incredible price of just $3299

THE NEW INTEL MOBILE PENTIUM® II PROCESSOR 366MHZ PUTS THE POWER OF A DESKTOP RIGHT IN YOUR LAP

Introducing the Quantex I-1511 notebook–powered by Intel's *New* Mobile Pentium II processor 366MHz. Featuring Intel's new and improved 256K performance enhanced on-die cache technology, it is the fastest, most powerful CPU on the road, and you'll find it in this powerhouse notebook. Known as the world's first "desktop to go," the Quantex I-Series gives you all the bells and whistles you previously had to sit at your desk to enjoy. An enormous 15" Active Matrix display, long-lasting 12-cell Lithium Ion battery, ATI 3D AGP graphics accelerator with a whopping 8MB, and built-in dual bays for simultaneous use of DVD- or CD-ROM and floppy drives...the works. All in a little bundle of power that follows you anywhere. Have a nice trip.

Big On Screen. Small On Price. Quantex I-Series Notebooks are now available with "XX-Large" 15" displays Check them out starting at just $2799

I-SERIES NOTEBOOKS

Quantex I-1400 $1999

Business lease: $70/Mo. **Order Code #pcm0356**

- Mobile Pentium® II processor 266MHz
- ***New* 256K Performance Enhanced On-Die Cache**
- 14.1" XGA Active Matrix Display
- 64MB SDRAM
- 4GB Ultra ATA HD 56K V.90 Fax/Modem
- Removable Combo 24X CD-ROM Drive & 3.5" Floppy Drive
- New ATI Rage LT Pro 3D AGP Video w/8MB
- New ESS 3D Wavetable Surround Sound and Speakers
- New Long Lasting 12 Cell Smart Lithium Ion Battery
- USB and Fast IR Ports Integrated Personal Touchpad
- MS Windows 98 Corel Office Suite 8
- Quantex Carrying Case Year 2000 Compliant
- 3 year limited warranty on CPU and Main Memory
- 1 Year parts and labor warranty on all other components
- *Upgrade from 64MB SDRAM to 128MB SDRAM, add $149*
- *Upgrade from 4GB Ultra ATA HD to 6GB Ultra ATA HD, add $129*

Quantex I-1411 $2599

Order Code #pcm0359

Above system with NEW Mobile Pentium II processor 333MHz, 6.4GB HD, Removable 2X DVD-ROM Drive and Microsoft Office 97 SBE v2.0

INTRODUCING!

Quantex I-1511 $3299

Business lease: $110/Mo. **Order Code #pcm0361**

- ***New* Mobile Pentium® II processor 366MHz**
- ***New* 256K Performance Enhanced On-Die Cache**
- 15" XGA Active Matrix Display
- 128MB SDRAM
- 8GB Ultra ATA HD 56K V.90 Fax/Modem
- Removable Combo 2X DVD-ROM Drive & 3.5" Floppy Drive
- New ATI Rage LT Pro 3D AGP Video w/8MB
- New ESS 3D Wavetable Surround Sound and Speakers
- New Long Lasting 12 Cell Smart Lithium Ion Battery
- USB and Fast IR Ports Integrated Personal Touchpad
- MS Windows 98 Microsoft Office 97 SBE v2.0
- Quantex Carrying Case Year 2000 Compliant
- 3 year limited warranty on CPU and Main Memory
- 1 Year parts and labor warranty on all other components
- *Add Quantex Mini Docking Station for just $149*
- *Upgrade to Quantex Deluxe Carrying Case, add $99*

Quantex I-1510 $2799

Order Code #pcm0360

Above system with NEW Mobile Pentium II processor 333MHz 64MB SDRAM and 6GB Ultra ATA HD

CALL TODAY AND ORDER

800•346•6572

www.quantex.com/pcmag

In Canada, call 800•793•4167

VALUE MULTIMEDIA

QP6/400 M-1c $1099

Business lease: $39/Mo. Order Code #pcm0305

- New Intel Celeron Processor 400MHz
- 64MB SDRAM Memory, 128KB Secondary Cache
- 6.4GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 15" Digital Monitor w/ OSD, 15.9" viewable
- Toshiba MVACT2 3D DVD Media Accelerator w/ 8MB SDRAM
- DVD-ROM Drive upgrade to DVD-RAM
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- New ATX Mid Tower Desktop, ROM drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ACS 45 Speakers
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Mouse
- MS Windows 98 Value Multimedia Software Bundle
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Upgrade to 17" Monitor w/ 15.9" viewable, add $99
- Upgrade to 64MB SDRAM, add $79

QP6/333 M-1c(w/Intel Celeron processor 333MHz)...$1049
QP6/350 M-1x(w/Pentium II processor 350MHz).....$1149

SOFTWARE: Corel Office Suite 8 • Internet the Cat • Compton's Interactive Encyclopedia • Bob Works 6.0 • Amazon Trail • MS Money '97 (pre-loaded only) • American Heritage Talking Dictionary • Dr. Solomons Find virus (pre-loaded only) • Compton's Reference Collection • MS Internet Explorer 4.0

QP6/400 M-2x $1499

Business lease: $53/Mo. Order Code #pcm0306

- Pentium II Processor 400MHz
- 64MB SDRAM Memory, 512KB Secondary Cache
- 10GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 17" Digital Monitor w/ OSD, 16.0" viewable
- Toshiba MVACT2 3D DVD Media Accelerator w/ 8MB SDRAM
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- 3rd Generation 4.6X DVD-ROM Drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ACS 90 Speakers
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Mouse
- MS Windows 98 Value Multimedia Software Bundle
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Upgrade to 19" Monitor w/ 18.0" viewable, add $279
- Upgrade to 128MB SDRAM, add $279

QP6/350 M-2x(w/Pentium II processor 350MHz).....$1349

QP6/400 M-3x $1599

Business lease: $56/Mo. Order Code #pcm0307

- Pentium II Processor 400MHz
- 64MB SDRAM Memory, 512KB Secondary Cache
- 13GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 17" Digital Monitor w/ OSD, 16.0" viewable
- Toshiba MVACT2 3D DVD Media Accelerator w/ 8MB SDRAM
- expand 128MB Zip Drive with one cartridge
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- 3rd Generation 4.6X DVD-ROM Drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ACS 90 Speakers
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Mouse
- MS Windows 98
- Value Multimedia Software Bundle
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Upgrade to 19" Monitor w/ 18.0" viewable, add $279

QP6/350 M-3x(w/Pentium II processor 350MHz).....$1449

QP6/450 Best Buy $1999

Business lease: $70/Mo. Order Code #pcm0308

- Pentium II Processor 450MHz
- 128MB PC100 SDRAM Memory, 512KB Secondary Cache
- 10GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 19" Digital Monitor w/ OSD, 18.0" viewable, 1600x1200, 26dp
- Intel 740, 3D 2X AGP Graphics with 8MB SDRAM
- 3rd Generation 4.8X DVD-ROM Drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ACS 90 Speakers
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Mouse
- MS Windows 98 Value Multimedia Software Bundle
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Optional Iomega Zip Drive with one cartridge, add $79
- Add Sony CD-RW Drive for only $299
  (24X CD-R/ 10X CD-RW/ 24X CD-ROM)

QP6/400 Best Buy(w/Pentium II processor 400MHz)..$1799

POWER MULTIMEDIA

QP6/350 SM-1x $1399

Business lease: $49/Mo. Order Code #pcm0320

- Pentium II Processor 350MHz
- 64MB PC100 SDRAM Memory, 512KB Secondary Cache
- 6.4GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 17" Digital Monitor w/ OSD, 16.0" viewable
- Intel 740, 3D 2X AGP Graphics with 8MB SDRAM
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- New 4.8X Max variable Speed CD-ROM Drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ACS 90 Speakers
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS IntelliMouse
- MS Windows 98
- Value Multimedia Software Bundle
- Microsoft Office 97 SBE v2.0
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Upgrade to 10.2GB Ultra ATA HD, add $49
- Upgrade to 20GB Ultra ATA HD, add $99
- Upgrade to Altec Lansing ACS 45 Powered Speakers with Subwoofer, add $49
- Optional Iomega Zip Drive with one cartridge, add $79

SOFTWARE: MS Office 97 Small Business Edition v2.0 • MS Money '97 (pre-loaded only) • Office Mate • Day Planner Pro • Power Business Plans • Form Designer Pro • Project Manager Pro • Labels Unlimited • Compton's Reference Collection • Dr. Solomons Find-Virus (pre-loaded only) • MS Internet Explorer 4.0

QP6/400 SM-2x $1799

Business lease: $63/Mo. Order Code #pcm0321

- Pentium II Processor 400MHz
- 128MB PC100 SDRAM Memory, 512KB Secondary Cache
- New 10.2GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 17" Digital Monitor w/ OSD, 16.0" viewable
- New 32X 128 bit Creative SoundBlaster 3D AGP w/ 4MB Sound Increased Memory, Vivaldo2 3D Technology
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- 3rd Generation 4.8X DVD-ROM Drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ACS 90 Speakers
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS IntelliMouse
- MS Windows 98 Value Multimedia Software Bundle
- Microsoft Office 97 SBE v2.0
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Upgrade to Altec Lansing ACS 45 Powered Speakers with Subwoofer, add $49
- Optional Iomega Zip Drive with one cartridge, add $79

QP6/350 SM-2x(w/Pentium II processor 350MHz).....$1649

QP6/400 SM-3x $1999

Business lease: $70/Mo. Order Code #pcm0322

- Pentium II Processor 400MHz
- 128MB PC100 SDRAM Memory, 512KB Secondary Cache
- 13GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- New 19" Monitor w/ NLC CromaClear CRT, 18.1" viewable, 1600x1200, 26dp
- New 32X 128 bit Creative SoundBlaster 3D AGP w/ 4MB Sound Increased Memory, Vivaldo2 3D Technology
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- 3rd Generation 4.8X DVD-ROM Drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ACS 45 Powered Speakers with Subwoofer
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS IntelliMouse
- MS Windows 98 Value Multimedia Software Bundle
- Microsoft Office 97 SBE v2.0
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Optional Iomega Zip Drive with one cartridge, add $79
- Upgrade from 13GB to 20GB HD, add $49

QP6/350 SM-3x(w/Pentium II processor 450MHz)....$2199

QP6/450 SM-4x $2399

Business lease: $84/Mo. Order Code #pcm0323

- Pentium II Processor 450MHz
- 128MB PC100 SDRAM Memory, 512KB Secondary Cache
- New 17.2GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- New 19" Monitor w/ NLC CromaClear CRT, 18.1" viewable, 1600x1200, 26dp
- New 32X 128 bit Creative SoundBlaster 3D AGP w/ 4MB Sound Increased Memory, Vivaldo2 3D Technology
- expand 128MB Zip Drive with one cartridge
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- 3rd Generation 4.8X DVD-ROM Drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ADA 315 Dolby Pro Logic Surround Sound Speakers with subwoofer
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS IntelliMouse
- MS Windows 98 Value Multimedia Software Bundle
- Microsoft Office 97 SBE v2.0
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Optional Iomega Zip Drive with one cartridge, add $79
- Upgrade from 13GB to 20GB HD, add $49
- Add Sony CD-RW Drive for only $249
  (24X CD-R/ 10X CD-RW/ 24X CD-ROM)

SUPER MULTIMEDIA

QP6/450 M-4x SE $2199

Business lease: $77/Mo. Order Code #pcm0309

- Pentium II Processor 450MHz
- 128MB PC100 SDRAM Memory, 512KB Secondary Cache
- New 17.2GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 19" Monitor w/ OSD, 18.1" viewable, 1600x1200, 26dp
- Intel 740, 3D 2X AGP Graphics with 8MB SDRAM
- expand 128MB Zip Drive with one cartridge
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- 3rd Generation 4.8X DVD-ROM Drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ACS 90 Speakers
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Mouse
- MS Windows 98
- Value Multimedia Software Bundle
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Optional Altec Lansing ACS 45 Powered Speakers with Subwoofer, add $49
- Add Sony CD-RW Drive for only $249
  (24X CD-R/ 10X CD-RW/ 24X CD-ROM)

QP6/400 M-4xSE(w/ Pentium II processor 400MHz)..$1999

QP6/450 SM-4x SE $2799

Business lease: $98/Mo. Order Code #pcm0324

- Pentium II Processor 450MHz
- 128MB PC100 SDRAM Memory, 512KB Secondary Cache
- New 20GB 100ATA Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 21" Monitor w/ OSD, 20.0" viewable, 1600x1200
- New 32X 128 bit Creative SoundBlaster 3D AGP w/ 4MB Sound Increased Memory, Vivaldo2 3D Technology
- expand 128MB Zip Drive with one cartridge
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- 3rd Generation 4.8X DVD-ROM Drive
- SoundBlaster AudioPCI 64V Wavetable 3D Sound
- Altec Lansing ADA 315 Dolby Pro Logic Surround Sound Speakers with subwoofer
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS IntelliMouse
- MS Windows 98 Value Multimedia Software Bundle
- Microsoft Office 97 SBE v2.0
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Add Sony CD-RW Drive for only $249
  (24X CD-R/ 10X CD-RW/ 24X CD-ROM)

ULTIMATE GAMING PCS

QP6/400 GX-1c $1499

Business lease: $53/Mo. Order Code #pcm0340

- New Intel Celeron Processor 400MHz
- 96MB SDRAM Memory, 128KB Secondary Cache
- 13GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 17" Digital Monitor w/ OSD, 15.9" viewable
- Intel 740, 3D 2X AGP Graphics with 8MB SDRAM
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- New 48X Max variable Speed CD-ROM Drive
- Aureal A3D 3D Positional PC Sound
- 3Dfx Voodoo2 Based 3D Game Accelerator w/ 12MB
- MS SideWinder Precision Pro Joystick
- Altec Lansing ACS 45 Powered Speakers with subwoofer
- Quantex ATX Mid Tower Case
- 104 key keyboard with MS Mouse
- MS Windows 98 Value Multimedia Software Bundle
- Activision Game Titles: Battlezone, Heavy Gear, Interstate '76 & Nuclear Strike
- 3 year limited warranty with 1 year On Site Service**
- Year 2000 Compliant
- Upgrade to 17" Monitor w/ NFC Diamondtron CRT, add $79

QP6/450 GX-2 $2399

Business lease: $84/Mo. Order Code #pcm0342

- Pentium II Processor 450MHz
- 128MB PC100 SDRAM Memory, 512KB Secondary Cache
- 10GB Ultra ATA HD, 3.5", 1.44MB Floppy Drive
- 19" Digital Monitor w/ OSD, 18.1" viewable, 1600x1200, 26dp
- Intel 740, 3D 2X AGP Graphics with 8MB SDRAM
- expand 128MB Zip Drive with one cartridge
- 56K v.90 PCI Fax/Modem* w/ Voice Mail and Speakerphone
- 3rd Generation 4.8X DVD-ROM Drive
- Aureal A3D 3D Positional PC Sound
- New Dual 3Dfx Voodoo2 SLI 3D Game Accelerators w/ 24MB 2X more powerful than single Voodoo2 accelerator
- MS SideWinder Precision Pro Joystick
- Altec Lansing ADA 305 Dolby Pro Logic Surround Sound Speakers & subwoofer
- Quantex ATX Mid Tower Case
- 104 key Keyboard with MS Mouse
- MS Windows 98 Value Multimedia Software Bundle
- Activision Game Titles: Battlezone, Heavy Gear, Interstate '76 & Nuclear Strike
- Year 2000 Compliant

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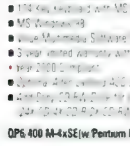


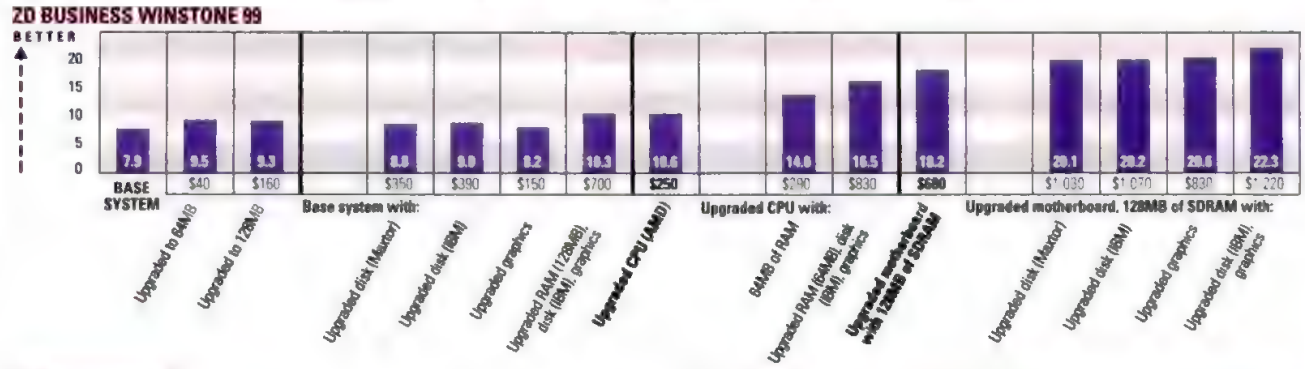
800·346·6572

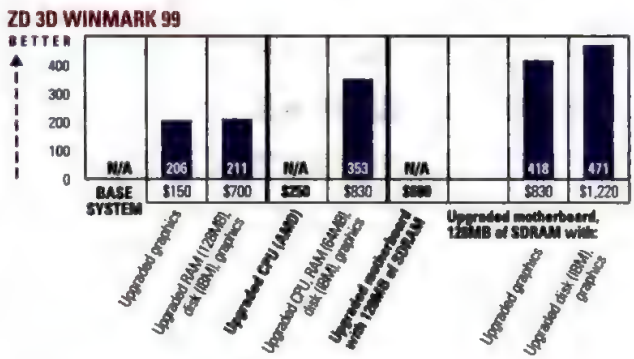
www.quantex.com/pcmag

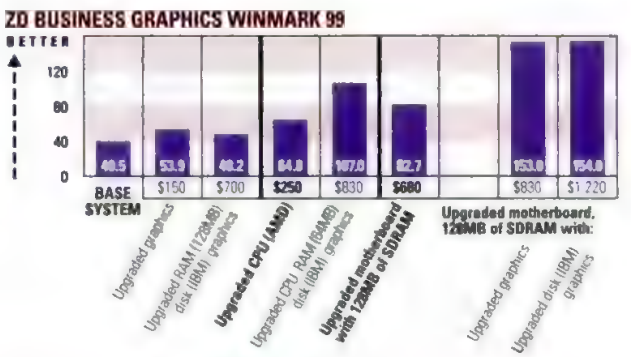
In Canada, call 800·793·4167

TEST RESULTS: PENTIUM/200 SYSTEM AND UPGRADES

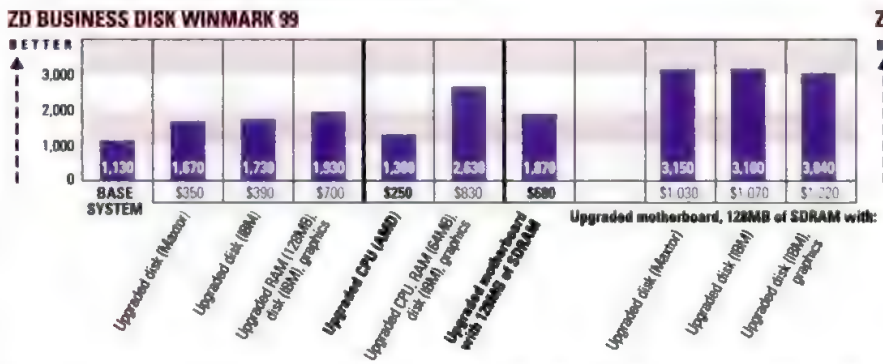
Base system: Pentium/200, 32MB of EDO DRAM, 512K L2 cache, 1.6GB Western Digital EIDE hard disk, Matrox Millennium graphics card with 4MB WRAM.
Upgrade parts: *Motherboard*—SuperMicro P6SBA with Pentium II/400, 512K L2 cache ($500), and 128MB of SDRAM (100-MHz DIMM) ($180); *CPU*—PowerLeap AMD K6-2/400 ($250); *RAM*—32MB of EDO SIMM ($40 each); *disk*—17.2GB 5,400-rpm Maxtor Ultra ATA ($350) or 14.4GB 7,200-rpm IBM Ultra ATA ($390); *graphics*—Creative Labs TNT PCI with 16MB of SDRAM ($150). For *RAM* upgrades, we used EDO RAM unless otherwise indicated. The figure in parentheses is the total RAM after the upgrade.

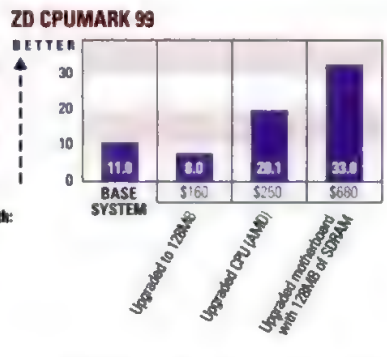






N/A—Not applicable. The unit's graphics card could not complete this test.





this amounted to a 0.33-percent-per-dollar gain with CPUmark. And with Winstone, where performance differences are most noticeable to users, it was just 0.12 percent per dollar. But this upgrade is enough to bring you to the performance level of one of our new PCs all by itself. You'll notice the improvements most on applications that are processor-intensive, including CAD, 3-D gaming, speech recognition, and image processing. The K6-2 also supports 3DNow! technology; for a list of 3DNow!-enabled applications, go to *www.amd.com/products/cpg/k623d/optimized.html*.

Adding memory to the PowerLeap-equipped system to bring it up to 64MB boosted the gains to 78 percent on CPUmark 99, yielding 0.27 percent per dollar. Next, we added in the IBM hard disk upgrade and the Creative Labs TNT adapter—a total cost of $825. The final tally for the improvements was significant, yielding performance that was nearly 50 percent better than that of our best-performing new system, the $899 IBM Aptiva E2U. You're getting a return of 0.06 percent per dollar for Business Winstone with the upgrade. The new IBM yields far less, though, at 0.02 percent per dollar. As with the Gateway PC, however, you miss out on some new technology, such as AGP graphics, the new warranty, and a faster modem.

MOTHER'S DAY

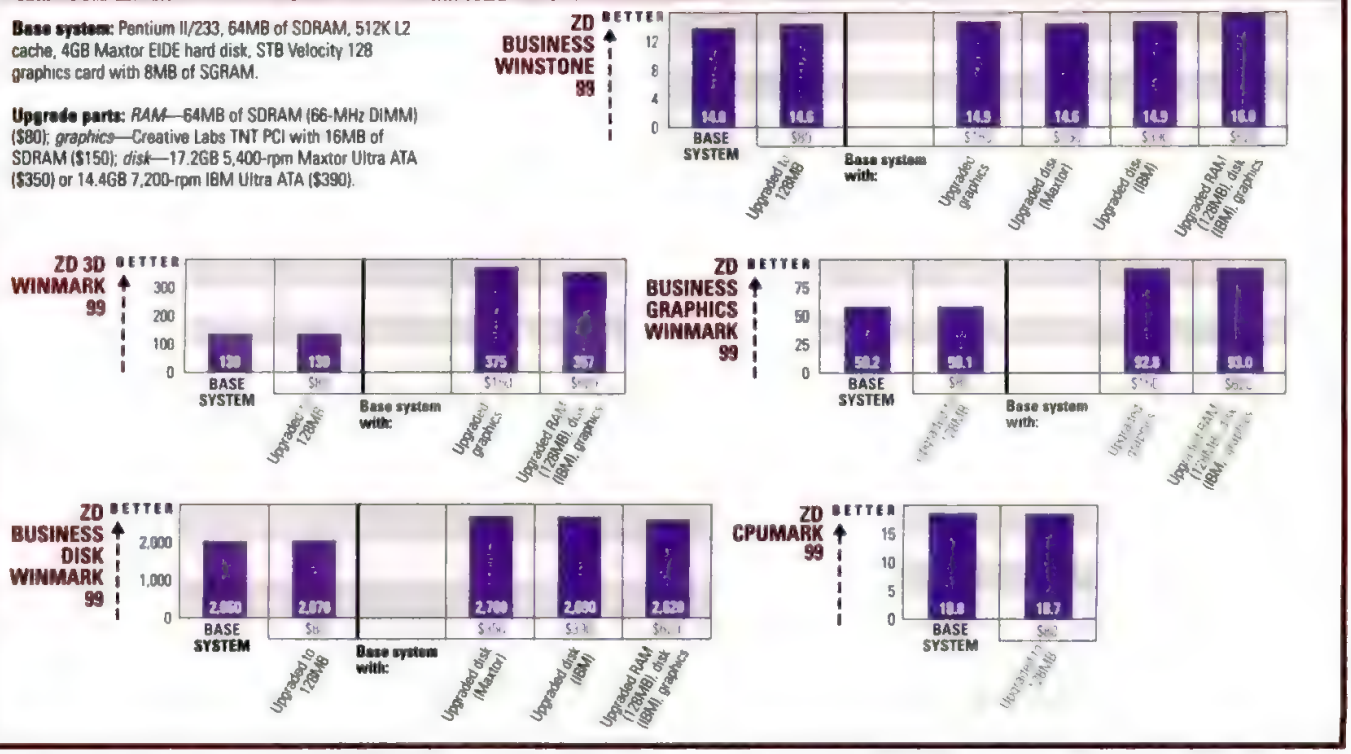
Having gone this far, it was time to see what a full motherboard upgrade could offer. Upgrading the motherboard rather than just the CPU lets you take advantage of new technologies, such as AGP and the 100-MHz bus architecture. On the downside, motherboard upgrades are complex, requiring at least 1 hour to complete, and even longer to troubleshoot.

But the performance gains are dramatic. Using a SuperMicro P6SBA mother-

TEST RESULTS: PENTIUM II/233 AND UPGRADES

Base system: Pentium II/233, 64MB of SDRAM, 512K L2 cache, 4GB Maxtor EIDE hard disk, STB Velocity 128 graphics card with 8MB of SGRAM.

Upgrade parts: *RAM*—64MB of SDRAM (66-MHz DIMM) ($80); *graphics*—Creative Labs TNT PCI with 16MB of SDRAM ($150); *disk*—17.2GB 5,400-rpm Maxtor Ultra ATA ($350) or 14.4GB 7,200-rpm IBM Ultra ATA ($390).



board, we installed a Pentium II/400 CPU and 128MB of 100-MHz SDRAM for a total cost of $680. Using the same hard disk and graphics card from the original Pentium/200 system, the Business Winstone score still more than doubled and was well over that of the new IBM Aptiva PC, for $200 less. On a percent-per-dollar basis, you get a 0.20 return on Winstone. If you are technically adept and can spare the time, you will see marked improvements with a motherboard upgrade.

Finally, we added in the IBM hard disk and an AGP Creative Labs graphics card for a total upgrade cost of $1,215. The Winstone score was nearly three times that of the original system and we now had a fast 3-D graphics card and 12GB more space. The Winstone boost yields a 0.15-percent-per-dollar return on the upgrade. By this point, however, you've spent at least 2.5 hours performing the upgrades, and you still have more hours ahead of you troubleshooting the new parts. So you're probably better off investing in an equivalently priced new system.

PENTIUM II UPGRADES

We then took our base Pentium II/233 system and ran through a smaller set of similar upgrades. The unit started with 64MB of RAM, a 4GB Maxtor DiamondMax hard disk, and an STB Velocity 128 AGP graphics card with 8MB of SGRAM. We increased RAM to 128MB (at a cost of $80); we also tested the same IBM and Maxtor hard disks and the Creative Labs TNT graphics card in an AGP version.

A good 3-D graphics card is a quick and inexpensive way to boost performance significantly.

Almost none of the changes here made a significant gain in terms of percent improvement per dollar, except for the graphics card. When we used the base configuration and changed the card, the Business Graphics WinMark score improved to 0.38 percent per dollar, and the 3D WinMark score rocketed up by 1.13 percent per dollar—the largest gain posted on any test in the entire project. But if you don't run applications that rely on 3-D acceleration or perform heavy 2-D image editing tasks, this gain is not important.

The hard disk upgrades yielded just over 30 percent better performance over the base unit. You're getting 10GB to 13GB more storage.

The only other upgrade worth mentioning is the upgrade from 64 to 128MB of memory, which paid off at 0.07 percent per dollar for the Winstone score. Another benefit: far less disk swapping. Adding all the upgrades, for a total cost of $620, actually turned out to have a lower return: 0.02 percent per dollar for the Winstone test (a 14 percent performance boost). Stick with targeted upgrades to fix a problem, or spend at least $1,900 on a new 400-MHz Pentium II system. The reviews that follow will help you pick the products that fit your needs and budget.

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CPUs AND MOTHERBOARDS

As our testing proved, installing a new CPU is relatively easy and can significantly improve the performance of an older PC. But to take advantage of the latest PC architecture advancements, such as AGP graphics and the 100-MHz system bus, you'll need to replace your entire motherboard with one based on the Intel 440BX chip set. Be warned: This can be somewhat time-consuming and makes sense only if you've already replaced a number of internal components (hard disk drive, graphics card, sound card, DVD drive) and don't want to walk away from that investment.

PROCESSOR UPGRADES

At the moment, there's no way to upgrade an older Pentium machine to an Intel Pentium II or Celeron chip without first upgrading the motherboard. This restricts available processor upgrades to lower-end CPUs, such as the AMD K6-2, IDT WinChip, or standard Pentium. And of these, only the K6-2 even approaches the performance levels of today's high-end machines.

Priced from $200 to $350, K6-2 upgrade chips are on sale from such companies as Evergreen Technologies, Kingston Technologies, and PowerLeap Products. These products can potentially bring an existing Pentium system to the level of a 233- or 266-MHz Pentium II, while providing access to AMD's new 3DNow! graphics technology. All three companies offer upgrade chips at a range of clock speeds, but in a market where even a 266-MHz Pentium II is considered slow, we recommend you look at 333-MHz or faster chips.

We tested the **PowerLeap PL-ProMMX 400** ($249.95 list), which is built around the 400-MHz version of the K6-2. (Another K6-2 upgrade processor—the 333-MHz, $249 Evergreen Spectra333—was not available in time for testing.) Accompanied by a brief but effective user guide, the PL-ProMMX 400 can be installed and booted in under 10 minutes.

After powering down, unplugging, and opening our test system, we lifted the ZIF (zero insertion force) lever on the motherboard and removed its CPU. Our testbed was a Pentium/200 equipped with 512K of secondary cache, 32MB of RAM, a modest 1.6GB hard disk, and a Matrox Millennium graphics card. Being careful to slide pin 1 of the PL-ProMMX 400 into pin 1 of the system's ZIF socket, we eased the upgrade chip into place and pushed the ZIF lever back down. We merely had to plug the system in and flip its power switch to reenter Windows. We then installed the bundled software utility to optimize performance.

The chip worked well without any accompanying hardware, software, or BIOS changes. Performance increases were healthy but not spectacular. With the new chip installed, our PC's Winstone score improved by over 20 percent, from 8.0 to 9.7. We then added a second 32MB memory module (priced at under $20) and saw the Winstone score leap to 12.7, an almost 60 percent improvement from the original score. (Today's sub-$1,000 Pentium II/300 machines score in the midteens.)

Unfortunately, the PL-ProMMX 400 can't be used with just any aging PC: Like the Evergreen Spectra and the Kingston TurboChip, it is compatible with most Pentium machines running at 75 MHz or higher—not all of them. You'll need to check with the upgrade vendor to see whether the CPU can be used with your system. (PowerLeap Products, Bellevue, WA; 877-278-5327; *www.powerleap.com.*)

All of this may be moot this spring if the upcoming **Evergreen EclipsePCI** lives up to its billing. A Celeron-based upgrade chip that sits on a PCI card, the Eclipse-

How to Install a Motherboard

BEFORE YOU START

Lightly touch your PC's metal chassis to discharge any current from your body. Then unplug the power cable.

WHAT YOU'LL NEED

1 ▼GENTLY DISCONNECT the main power cable, all IDE ribbon cables, the floppy disk drive's cable, any add-in cards, all peripherals, and the leads to all buttons, indicators, and speakers. You may also have to remove the PC's front panel or a fan or drive bay if it's obstructing the motherboard.

2 ▲REMOVE YOUR EXISTING MOTHERBOARD. Undo the few screws that hold it down, and lift it from your PC's chassis. This may require some force; make sure you apply pressure evenly across the board. Be careful not to cut yourself on the sharp pins protruding from the underside of the board.

PCI plugs neatly into the bus slots of any existing system with an available PCI slot. The card itself houses the CPU, half of the CPU's chip set, L2 cache, system memory, and possibly some additional hardware. Priced from $300 to $400, the first versions will use either a new, socketed incarnation of the 333-MHz Celeron or a current K6-2 chip. This is certainly an ingenious invention, but how well it will perform is anyone's guess. (Evergreen Technologies, Corvallis, OR; 888-607-7333; *www.evertech.com.*)

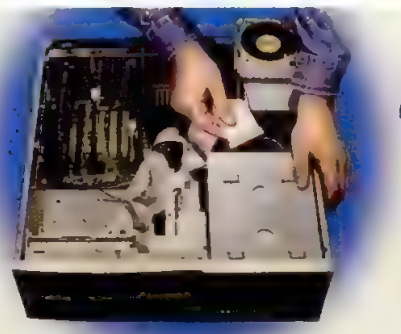
MOTHERBOARD UPGRADES

Until the EclipsePCI arrives and perhaps even afterward, the best way to upgrade an existing 486, Pentium, or slower Pentium II will be to replace the motherboard. Unfortunately, that is no simple task. In fact, it's major surgery that PC neophytes and the faint of heart should absolutely avoid. Physically adding the new board may not be difficult (it took us about half an hour), but configuring the board to run your OS properly requires hours of work.

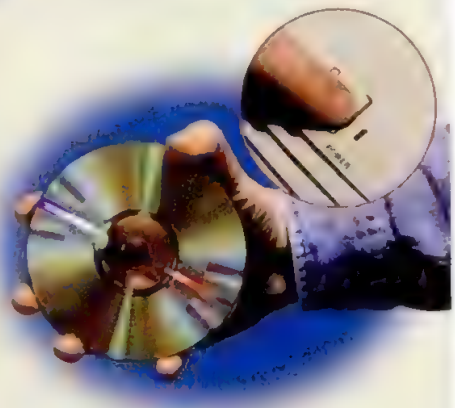
It also requires the purchase of several additional hardware devices. At the very least, you'll need a new high-end Pentium II processor (note that the price of the motherboard generally does not include the processor) and a new 100-MHz memory module. And you should also opt for a new hard disk and graphics card; old ones can severely hamper performance. But if you've already upgraded these other components, upgrading the motherboard may well be a reasonable next step.

If you choose to take the plunge, your first step is to determine the design of your existing motherboard. Most later Pentium models use ATX designs, but many 486 and early Pentium systems use the older Baby AT standard.

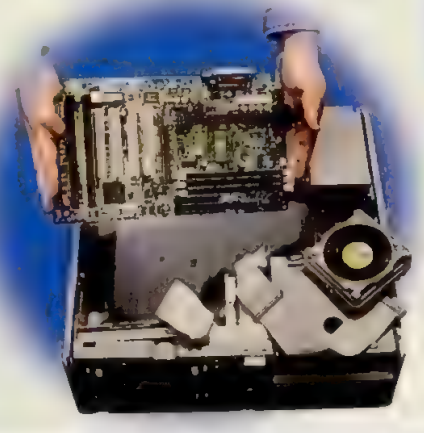
Next, discern whether your system uses an integrated audio chip or an audio peripheral card. If audio is integrated and you'd rather not purchase a new sound card, pick a new motherboard that integrates audio (typically an extra $20).



4 ◀CAREFULLY RECONNECT ALL CABLES AND PERIPHERALS. Using your motherboard's manual, connect all cables, leads, and peripherals. Make sure the light-red strip that runs along the edge of the ribbon cable for your IDE or floppy disk drive connection matches up with "pin 1" of the IDE or floppy disk drive slot being used.



3 ▼INSTALL YOUR NEW MOTHERBOARD. *Gently* fasten it to your PC's chassis with only one or two screws. Forcefully tightening multiple screws can damage the board's internal circuitry.



5 ▲TURN THE MACHINE ON AND BE PATIENT. Getting the new board to run your operating system may require many hours of work. Have your operating-system CD handy, and be prepared to load drivers, change settings, and reboot many times.

UPGRADE TIPS

CPUs

- To save money, consider a memory upgrade first. Buy a faster processor only if adding new RAM won't satisfy your performance needs.
- Consider buying a new PC, or even a new motherboard (if you're brave). After all, at the moment there's no way to add a Pentium II or Celeron processor to a 486- or Pentium-based motherboard.
- Consider waiting until this spring, when Evergreen Technologies will start selling a Celeron upgrade processor that sits on a PCI card and neatly attaches to your existing motherboard. We've yet to test this product, but it may prove a worthwhile and easy upgrade to the P6 platform.
- If your heart is set on an upgrade now, use an AMD K6-2 part from either Kingston or PowerLeap. These are the only chips that can perform anywhere near the levels of today's new systems.
- Beware of other performance bottlenecks, such as your hard disk or graphics card. These may be as ready for an upgrade as your CPU.

Whether you opt for a Baby AT or an ATX board, and whether you choose a board that comes with or without audio, it must in any case use Intel's 440BX chip set. Like past Pentium II chip sets, the 440BX supports AGP; but the 440BX is the first to use Intel's new 100-MHz bus, thus alleviating one of the market's longest-standing bottlenecks. Without the 440BX and the fast bus, you won't be able to run Intel's future chips, let alone today's 350-, 400-, and 450-MHz Pentium IIs.

To upgrade our ATX-based test-bed, we chose four boxed 440BX motherboards from well-known manufacturers. You may be able to find them at retail outlets, but most are sold primarily to resellers and distributors.

Using a screwdriver, strong hands, and the documentation that came with the boards, we installed each motherboard (for details see "How to Install a Mother-

board"). We encountered no major faults and only a few minor glitches. Then, after installing a 400-MHz Pentium II, 128MB of memory, a 14GB hard disk, and a Creative Labs AGP graphics card, we tested each product and saw very similar results. All performed as well as many new 400-MHz machines, and all scores fell into a very narrow range.

The best product in general was the **Tyan S1846S/L/A**, typically priced from $100 to $120 without audio. This 8- by 12-inch board offers a healthy complement of I/O slots, including three DIMM, two PCI, one ISA, one shared, and one AGP. It also supports Wake on LAN, Ultra-DMA/33, and industry-standard health monitoring. In case you wish to use the latter, Tyan provides an optional $10 copy of Intel's LANDesk Client Manager.

Fully equipped, the S1846S/L/A scored 21.7 under Winstone, in the middle of the pack. Its Business Graphics WinMark and CPUmark scores—149 and 31.8 respectively—were also high (though slightly lower than those of the SuperMicro board). This board's true advantages, however, lie with its extensive documentation, three-year warranty, and U.S.-based technical-support offerings. Few motherboard companies support end users so directly. (Tyan Computer Corp., Fremont, CA; 510-651-8868; *www.tyan.com.*)

Bundling most of the same features as the S1846S/L/A, the **Intel SE440BX-2**, or "Seattle," is typically priced from $140 to $155, depending on whether you opt for audio. It performed only slightly below the S1846S/L/A on speed tests and offers a similar three-year warranty, though Intel chooses not to provide end users with technical support. Typically, for support you must go through the outlet where you purchased the board. (Intel Corp., Santa Clara, CA; 800-651-0163; *www.intel.com.*)

The **SuperMicro Super P6SBA** (typically $140 without sound) bested all comers on every speed test. Its basic features are similar to those of the three other products, though it adds an extra ISA slot. Unfortunately, SuperMicro doesn't offer technical support to users over the phone, though it does answer e-mail concerning its boards. (SuperMicro, San Jose, CA; 408-895-2000; *www.supermicro.com.*)

Though the **Diamond Micronics C400** comes with technical support and a full three-year warranty, it was the least impressive product, shipping with a terse setup poster in lieu of a user guide and delivering the poorest test scores by a small margin. But it's competent and inexpensive, providing technology comparable to that of its competitors despite costing under $130 with integrated audio. (Diamond Multimedia Systems Inc., San Jose, CA; 800-468-5846; *www.diamondmm.com.*)

Any of these boards can raise your machine to the level of a new 400- or 450-MHz Pentium II, now selling for $1,500 to $2,500 from leading manufacturers. Of course, once you spend $140 on a motherboard, you'll also need to spend roughly $550 on a 400-MHz Pentium II, $350 on a 128MB memory module, $350 on a hard disk, and $150 on a graphics card. That's almost as much as a new machine, and it doesn't take into account the hassles of installation.

In the midst of all this, that new $2,000 system can start to look mighty attractive.—*Cade Metz*

PC MAGAZINE EDITORS' HOT LINKS

www.pcmag.com/hotlinks
The online component of PC Magazine *is the first place to look for a real-time guide to core-component upgrades. If you're interested in learning more about motherboards, CPUs, and hard disks, surf these other useful Web sites.*

➤MicroDesign Resources
www.mdronline.com
A great site for technical information on new processors from AMD, Intel, and others, with articles from *Microprocessor Report.* MicroDesign resources is a subsidiary of Ziff-Davis (the publisher of *PC Magazine*).

➤PC Mechanic
http://pcmech.pair.com
A helpful resource for do-it-yourselfers, PC Mechanic discusses how PCs work and the roles of various components. It includes step-by-step upgrade guides and sections on CPUs, motherboards, hard disks, graphics cards, and monitors.

➤Intel Developers' Site
http://developer.intel.com
Sponsored by Intel, this site has extensive technical information on new and existing Intel products, including processors, motherboards, memory, and peripherals.

➤Intel Secrets
www.x86.org
Robert Collins has made his mark by exposing many of Intel's "technical secrets," providing very good behind-the-scenes articles and solid technology pieces on Intel motherboards and processors.

➤AMD
www.amd.com
A rival to Intel, AMD makes the capable and popular K6 processor, bundled in many low-cost PCs. The company's Web site includes extensive technical information on its products, including the latest K6 processors.

➤IBM Storage Systems Division
www.storage.ibm.com
IBM's Web site includes an in-depth explanation of its magnetoresistive heads, which the company uses in its own hard disks and licenses to other companies as well.

UPGRADE TIPS

Motherboards

- Not comfortable installing PC hardware? Then don't bother. Upgrading a motherboard requires a fair amount of expertise and often hours of work. If you're inexperienced or faint of heart, just buy a new PC.
- Find out your existing motherboard's design: Some are Baby AT, others ATX. Check your documentation to be sure you're purchasing the right one to match the PC's chassis and power supply.
- Opt for a motherboard based on the Intel 440BX chip set. Though AMD is competing successfully in the retail market, Intel motherboards, chip sets, and CPUs are best for the latest features and a more promising upgrade path.
- Make sure your new motherboard offers USB and AGP. New Pentium II and Celeron boards are almost always equipped with these new interfaces; a motherboard that lacks them will hamper your ability to add peripherals.
- Check for integrated audio. If your existing motherboard has a built-in audio chip and audio I/O ports, you might want an upgrade board that also has these features—unless you're ready to buy a new sound card.

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HARD DISKS

One of the best ways to boost your PC's usefulness and extend its life span is to increase its hard disk capacity. Desktop drive prices have dropped so low and installation has become so easy—particularly under Microsoft Windows 98—that replacing an existing drive or adding a second one is now a very cost-effective and time-efficient option. For this story, we tested five desktop drives from the largest manufacturers, plus two leading drive-upgrade kits for laptops.

DESKTOP DISKS

Desktop users should consider drives in the range of 12GB to 17GB (about $250 to $380). All here are 3.5-inch units built for the standard IDE interface, and all meet the Ultra DMA (ATA-4) specification. Each comes with mounting rails and data cables. And unlike those in past years, each delivers bundled software that easily configures, partitions, and formats your new drive, while helping transfer data from an existing drive to the new one—including boot information.

Upgrading a hard disk in a new system (less than a year old) should not be a problem in most systems; we had no trouble with our 300-MHz Pentium II test beds. Older systems, however, typically have BIOSs that can't see partitions greater than 2GB or 8GB. If you are using a hard disk larger than this, you'll need to use the overlay software that's provided with it, which can be intimidating for the less technical to use. If you're worried, the store where you bought the new drive probably offers an install service for $50 or so.

As for performance, mainstream users won't detect a huge difference from one drive to the next. In fact, on our Winstone 99 test suite (which models real-life application usage), all scores fell within a 0.6-point spread. We saw more noticeable divergences in disk access times and data-transfer rates. So for disk-intensive applications that employ large files (such as video and image editing), a better-performing drive can save a few seconds on every File | Open and File | Save command, which can add up over a day.

The 14.4GB **IBM Deskstar 14GXP** ($330 street), which boasts a rotational speed of 7,200 rpm, was slightly faster than the competition on our disk access tests, at 13.6 milliseconds (ms). It is bundled with Ontrack Data International's Disk Manager—software for configuring, partitioning, and formatting a new disk as well as for transferring data from an original drive. (IBM Storage Systems Division, San Jose, CA; 888-426-5214; *www.ibm.com/harddrive.*)

The 17.2GB **Maxtor DiamondMax 4320** ($380 street) comes with MaxBlast, the company's automated installation software. MaxBlast accurately assesses the drives in the current system and prints out a customized installation guide. If you lack a printer, it indicates on-screen the essential information needed to install the drive in your system. A 5,400-rpm disk, the Maxtor was a surprisingly competent performer. (Maxtor Corp., Longmont, CO; 800-262-9867; *www.maxtor.com.*)

The 12.7GB **Quantum Fireball EX 12GB** ($250 street) is the only drive here that sells with extra software for special functions. In addition to Ontrack's Disk Manager, the Fireball EX includes the graphics software CorelDraw! 6 Select and Norton Smart Doctor. This 5,400-rpm drive performed solidly on our speed tests, trailing the pack only on our burst data-transfer tests, where it landed just shy of the IBM disk—a mere 6 percent slower than the group's average. (Quantum Corp., Milpitas, CA; 800-624-5545; *www.quantum.com.*)

The 9.1GB **Seagate Medalist Pro 9140** ($240 street) is the same 7,200-rpm disk we tested for last year's upgrade story, when the street price was twice as high. To install, you must first run its animated installation

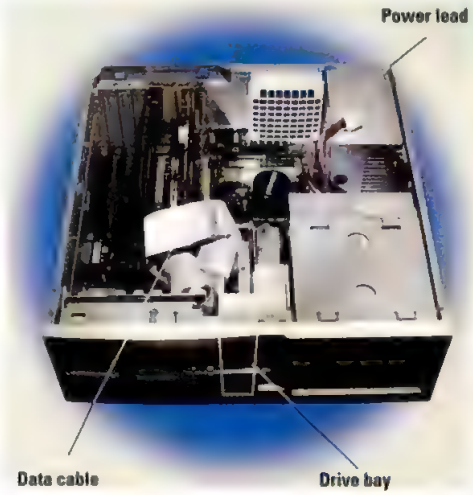
How to Install a Hard Disk

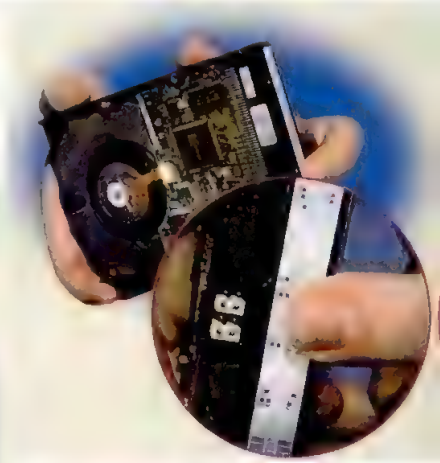
BEFORE YOU START

Lightly touch your PC's metal chassis to discharge any current from your body. Then unplug the power cable.

WHAT YOU'LL NEED

1 ▼BACK UP YOUR MOST IMPORTANT DATA FILES, turn off your PC, and unplug the power cable. Open your PC case and locate a drive bay, data cable, and power lead that will be used for your new hard disk. You may need to remove the PC's plastic front panel.





2 ▲MAKE SURE THE JUMPERS for the old and new drives match the intended use, whether as *master, slave,* or *sole drive* on the primary IDE circuit. The manual is usually clear on this point; sometimes the jumper setting choices are printed on the drive itself, or at the vendor's Web site.

and configuration software. In our labs, we were impressed that the program detected an incorrectly entered model number, recognized the proper drive, and prompted the user to continue with automatic installation. The Medalist Pro performed near the top on all of our speed tests. (Seagate Technology Inc., Scotts Valley, CA; 800-732-4283; *www.seagate.com.*)

The **Western Digital WD Caviar 13GB** ($250 street) includes a detailed installation guide and user manual. While most users will probably never look at the manual, it's still a valuable reference source. This fine 5,400-rpm drive topped our Winstone testing by a hair's breadth, though it trailed by an equally tiny margin on our sustained data-transfer rate tests. (Western Digital Corp., Irvine, CA; 800-832-4778, 949-932-4900; *www.westerndigital.com.*)

NOTEBOOK DISKS

Because laptop computers don't have a standard internal design as desktop PCs do, upgrading a notebook's hard disk means buying a special kit for your machine. Notebook kits cost more per gigabyte than desktop drives, in part because they include PC Cards and transfer cables.

We received kits from Apricorn and CMS Peripherals. Each came to us in two versions to accommodate our two test PCs, an IBM ThinkPad 560E and a Toshiba Portégé 620T. All the units use PCMCIA cards and cables to transfer data from the existing internal drive before swapping. All come with data-transfer software.

The drive replacement process is fairly standardized, though the time it takes to transfer data to a new drive varies depending on the type of notebook, disk, and data. In our labs, running the software and making the transfer were simple; in each case, the software recognized and analyzed the old drive as well as the new disk, which we connected temporarily via cable and PC Card. After we responded to a start-up prompt, the transfer took place automatically, and we removed the original drive and replaced it with the new one. (Each company lets you use the old unit as an external backup device.) Removing an internal drive isn't a major operation, but it can be time-consuming if your machine doesn't have a removable drive design.

UPGRADE TIPS

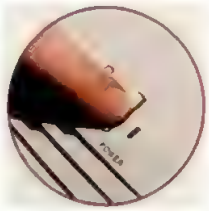
Hard Disks

- If your PC's BIOS doesn't support the capacity of your new drive, you'll have to work around the problem by running utility software (often bundled with the upgrade drive).
- If your operating system doesn't recognize disk partitions larger than 8.4GB, you'll need to configure the new drive into multiple logical drives—or else run utility software (usually bundled) that forces the system to work with larger partitions.
- If your PC has no available power-cable plugs for attaching the new drive, you'll need to buy an internal Y-shaped power-splitter.

3 ▼PLACE THE NEW DRIVE IN THE SELECTED BAY.

4 ▲ATTACH THE PC's IDE ribbon cable and power cable to the drive. Each will probably be keyed to fit only one way.

5 ▶CLOSE YOUR PC's COVER, attach the main power cord, and turn on the system. The BIOS should recognize the new hard disk.



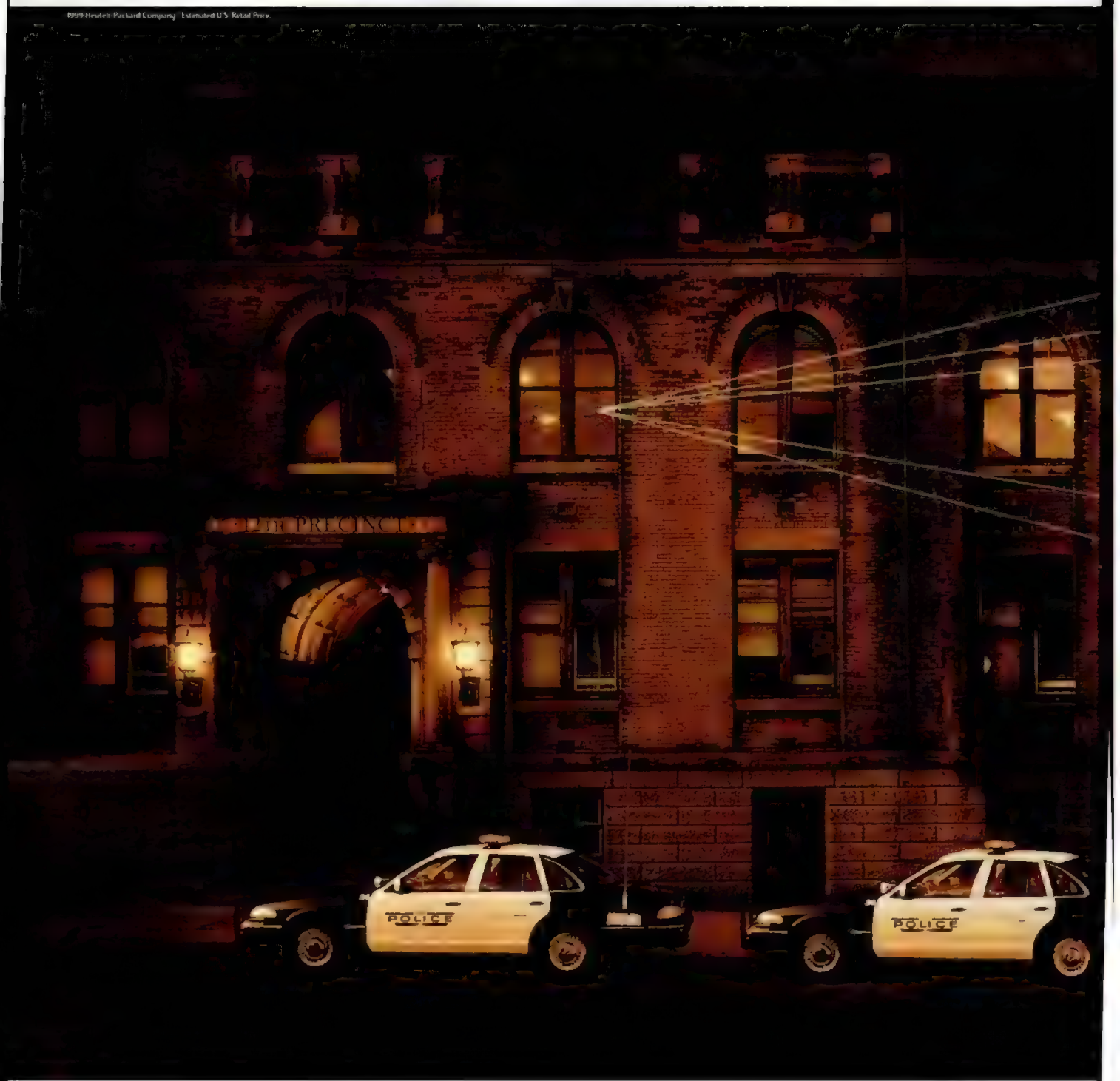
6 ▲RUN THE HARD DISK INSTALLATION SOFTWARE to partition and format the new drive. Finally, use the bundled software to transfer desired data from the original drive to the new one—including boot information, if necessary.

Both of the Apricorn kits were versions of the **Apricorn EZ-GIG:** a 6.1GB kit for the IBM ThinkPad 560E ($630 street; $100 per gigabyte) and a 5.1GB kit for the Toshiba Portégé 620T ($540 street; $105.69 per gigabyte). Apricorn includes model-specific information—without photos or diagrams—on the installation disk and on its Web site, for helping you remove and replace the original drive. (Apricorn Inc., Poway, CA; 800-458-5448; *www.apricorn.com.*)

Both CMS kits were 4GB versions of the **CMS EasyBundle**—one for the IBM PC and one for the Toshiba system ($500 street each, or $125 per gigabyte). Each comes with a brochure that has very helpful, model-specific photos to guide you. Each package also includes an antistatic wrist strap. The strap and the box are good ideas for cautious handling, though in normal practice neither is essential. (CMS Peripherals Inc., Costa Mesa, CA; 800-327-5773; *www.cmsperipheralsinc.com.*)

Replacing your notebook's hard disk isn't a trivial process. But if lack of storage space is the only reason you're dissatisfied, then investing the effort to replace your disk can be a smart move.—*Bruce Brown*

1999 Hewlett-Packard Company *Estimated U.S. Retail Price.



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office printers, the HP 2500C and 2000C. Both offer a redesigned cartridge system that uses four different ink cartridges. Result? Full-page graphics print at 4ppm. Operating costs drop sharply. And to ensure brilliant color, both printers feature our exclusive PhotoREt Color Layering technology. Visit www.hp.com/go/officecolor.

GRAPHICS ACCELERATORS

The graphics board industry is on a roll these days. Prices are down and performance is up, and top-notch 2-D/3-D combo boards stocked with 16MB of fast SDRAM routinely sell for less than $150. Although new developments will (as always) change the scene in another six to nine months, now is a good time to buy a new card for gaming, graphics, or business use.

For this story, we purchased seven graphics card upgrade kits from resellers across the country and ran them through our Winstone, Business Graphics WinMark, and 3D WinMark tests on an NEC Pentium II/300 base machine. We also took an early peek at a preproduction version of the new ATI Rage Fury 128, which promises to be a major player when it begins shipping in earnest later this year.

The growing maturity and acceptance of Microsoft's Direct3D API as a gaming platform provide the most obvious reason to replace an aging graphics card. Current offerings support 32-bit Direct3D graphics at resolutions as high as 1,600-by-1,200 and have enough off-screen memory to load the large, complex texture maps used in the latest 3-D games. Especially appealing as upgrade options are the new one-slot *convergence* boards, which bundle together a range of multimedia features—video capture, TV tuners, and so on—and still deliver great 2-D and 3-D performance.

Conversely, you can now easily upgrade individual features by adding a PCI-based specialty board to an existing system. Add-in cards based on the 3Dfx Voodoo2 chip set (such as the Diamond Monster 3D II or the STB BlackMagic 3D) can help solve your 3-D gaming woes without making you change your graphics card. Other popular add-ins include TV tuners, video-capture cards, and hardware-based DVD decoders.

AVOIDING THE WRONG CARD

Although the AGP bus has made graphics faster and easier for Intel Pentium II and Celeron machines, there are still roadblocks in the upgrade path. For starters, if your PC runs on an AMD processor or a previous-generation Pentium you'll need to stick with PCI. Several lines of currently shipping low-end PCs (including the Compaq Presario, Dell OptiPlex, and IBM Aptiva lines) provide AGP graphics through a soldered-on graphics chip (called a *down* chip). Although they use AGP now, they can't be upgraded with AGP cards in the future. But don't fret: Our test results show that topflight PCI-based boards can give these systems a substantial performance boost.

If you recently purchased an AGP2X machine that uses Intel's backplane NLX motherboard design, you'll need to check prospective upgrade cards to verify that they'll physically fit in your system. An NLX motherboard requires a different bracket to attach the graphics card to the rear of the computer case, constraining the placement of the 15-pin monitor port as well as the height and length of the card itself.

COMPARING THE PRODUCTS

An Editors' Choice in our last graphics card roundup ("Who's the Fastest?", December 1, 1998), the **Creative Labs Graphics Blaster RIVA TNT** offers fine performance thanks to its 16MB of SDRAM and excellent implementation of the nVidia RIVA TNT accelerator. The card posted exceptional scores on all of our 2-D, 3-D, and system-level tests and should perform even better in faster systems, such as the new 400- and 450-MHz Pentium IIs. ($140 street; Creative Labs Inc., Milpitas, CA; 800-998-1000; *www.creativelabs.com.*)

From Diamond Multimedia, the 16MB Voodoo Banshee–based **Diamond Monster Fusion** performed well in both AGP and PCI versions. Indeed, the PCI model earns our Editors' Choice as the top 2-D and 3-D choice for low-end systems (such as our Micron Pentium/200 baseline machine). In fact, the Monster Fusion posted a higher 3D WinMark score on our Pentium/200 test-bed PC than many cards did on a Dell Pentium II/400 in last November's roundup. A true gamer's delight, the Monster Fusion ships with Motocross Madness 2 and Unreal, and the board supports 3Dfx's GLide API as well as Direct3D and OpenGL. ($149 direct; Diamond Multimedia Inc., San Jose, CA; 800-468-5846; *www.diamondmm.com.*)

The inexpensive, AGP-only **Matrox Millennium G200** performed well on our Winstone and Graphics WinMark tests for this roundup, a fraction below the top-scoring

UPGRADE TIPS

Graphics Accelerators

- Some vendors still can't get plug-and-play right. To ease setup woes, before installing a new card, open Windows' Display Properties screen and change your adapter setting to "Standard Display Adapter (VGA)." Then turn off the machine and install the new card.
- The latest Intel NLX motherboards require a new style of bracket for add-in cards. Some graphics cards can be adapted for this system simply by unscrewing their brackets and replacing them with NLX-compliant versions, but others can't, because their 15-pin monitor connectors are mounted either too high or too low on the cards. Before you buy, check whether a new card will work with your system.
- Some current PCI graphics adapters require PCI 2.0 or PCI 2.1 compliance. Verify your system's PCI compliance level before attempting to upgrade the graphics card.
- Many low-end computers support AGP graphics via a "down" accelerator chip hardwired onto the motherboard; this is incompatible with a slot-based AGP card. If you have a PC that uses a down chip, you'll have to buy a PCI card if you're planning to upgrade.
- Some multifunction graphics cards are incompatible with hardware DVD decoders. If you plan to watch DVD movies on your PC, check carefully for this feature.

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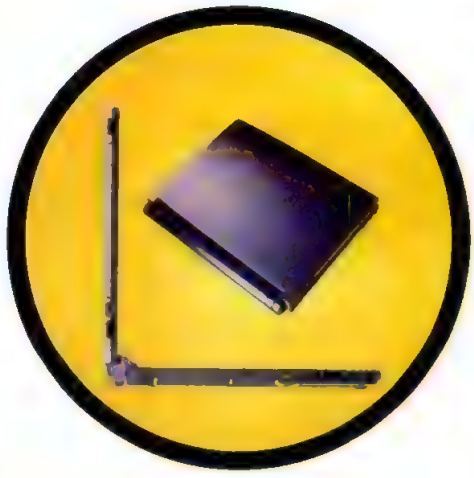

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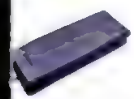
- **External 14X CD-ROM Drive** PCGA-CD5: **$299.99**



- **AC Adapter** PCGA-AC51: **$99.99**

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Swap any drives and battery to take only what you need.

The new Sony VAIO 838 Notebook is just what every power-hungry office nomad is looking for. More power and portability. Packed with our road-warrior **3MAX** features, this notebook offers **MaxMobility** (under 6 lbs. and less than 1.75" thin), **MaxScreen** (a full-color 13.3" high-resolution XGA display) and **MaxBattery** (up to 8 hours of power without a charge). Plus, the DVD-ROM drive, floppy disk drive, second battery[^] or second hard drive[^] are all interchangeable so you take only what you need. All told, it's a mighty powerful PC wrapped in a light and slim package.

Pre-installed Software:
- Windows 98
- Microsoft Outlook 98
- Microsoft Works
- Adobe PhotoDeluxe

3MAX Features:
- MaxMobility: Less than 7 lbs.^; 1.75" thin
- MaxScreen: 13.3" Active Matrix LCD Display
- MaxBattery: 2X battery life^^
- Using optional second battery in floppy drive bay

[^]Optional purchase required
^With weight saver floppy in drive bay.
^^With optional second hard drive and removable drive bay. Battery life may vary based on usage

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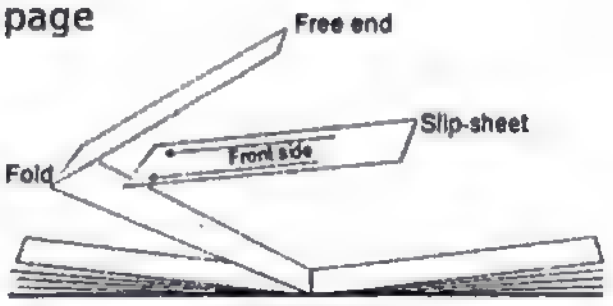

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you'll find: an Intel® Pentium® processor with MMX™ technology; crisp, clear disp
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- Microsoft® Outlook™ 98
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with dual battery capability for up to 7 hours[1] of on-the-go power. Plus, each moc
loaded with a host of software for some powerful multimedia capabilities. The o
didn't add to this notebook was weight and size. So you can see why **3MAX+™** m
MaxMobility, MaxScreen and **MaxBattery** plus a whole lot more.

3MAX+ Features (all models):
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- MaxBattery: 2X battery life
- MaxScreen: 14.1" XGA TFT

Plus:
- All-in-one design
- iLINK (IEEE-1394) port for DV still image capture

Pre-installed Software (all models):
- Windows 98
- Microsoft Outlook 98
- Microsoft Works
- Adobe PhotoDeluxe
- Sony Picture Gear
- Sony DVgate Still

60 days FR
access, no
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hours per
hours total
restrictions

[1]Using optional second battery in floppy drive bay. Battery life may vary based on u
[2]With weight saver in floppy drive bay

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- Integrated V.90 modem
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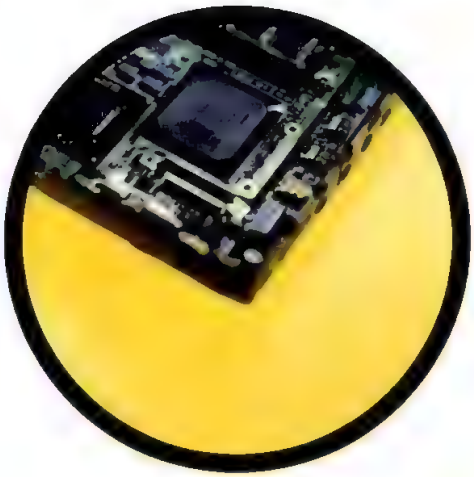

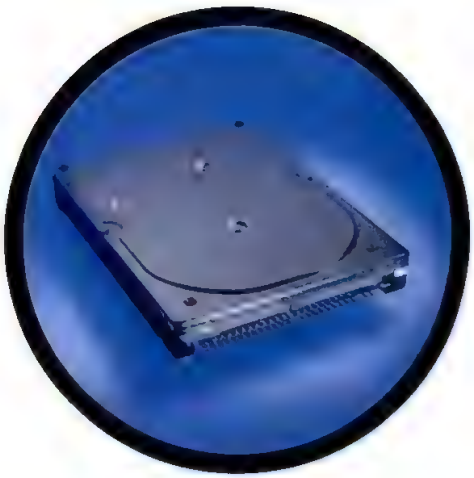

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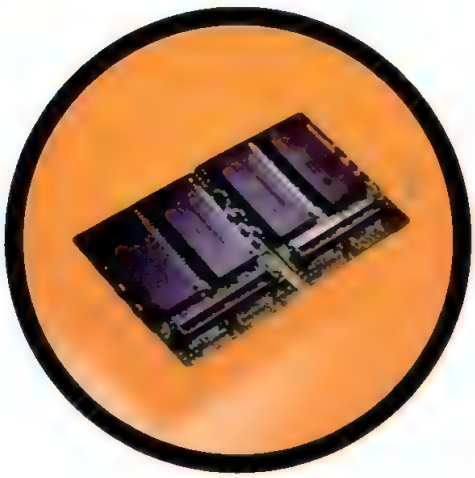

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*See advisories on back page

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4. Close the page and slip-sheet

Folded edge of the page

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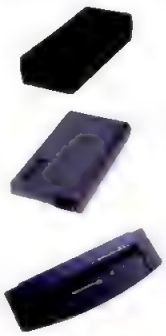

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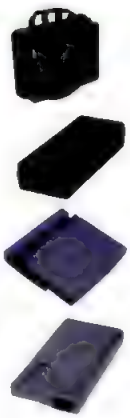
- V.90 modem
- High-capacity Lithium-Ion battery, dual battery capability
- 128-bit graphics acceleration
- Built-in stereo speakers
- Digital touch pad

3MAX

838 ACCESSORIES



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SN307-PM

Diamond Monster Fusion. But this 8MB card's 3-D performance remained well behind that of the 16MB RIVA TNT–and Voodoo Banshee–based boards we reviewed. (A memory upgrade to 16MB is available for about $45.) The G200's signal quality is very good, and the company offers a wide range of add-in daughtercards, including a hardware DVD decoder, digital flat-panel connector, and TV tuner. ($90 street; Matrox Graphics Inc., Dorval, Quebec, Canada; 800-361-1408, 514-685-7230; *www.matrox.com.*)

From the same company, the 8MB PCI-based **Matrox Marvel G200-TV** is a welcome addition to the convergence-board set, though its performance on our 200-MHz test-bed was disappointing. Under Winstone, the Marvel finished roughly 5 percent behind the pack-leading Monster Fusion, and its scores went downhill from there: The Banshee-based PCI Monster Fusion was almost 50 percent faster than the Marvel on our Graphics WinMark tests and more than three times as fast on our 3D WinMark tests. Still, the bundled goodies are impressive, including a TV tuner, frame-capture circuitry, and video-conferencing capability. Unlike its convergence-board competitors, the Marvel uses an external box for its audio and video connections, easing back-of-the-PC connection woes ($280 street; Matrox Graphics Inc., Dorval, Quebec, Canada; 800-361-1408, 514-685-7230; *www.matrox.com.*)

Combine its rock-bottom price, 16MB of SDRAM, and solid performance profile and the **Metabyte Wicked3D Vengeance** presents an attractive upgrade, especially for low-end Pentium-class machines. Its Winstone, Business Graphics WinMark, and 3D WinMark results were slightly lower than those of the Monster Fusion—but always within striking distance—yielding a firm second-place finish among our PCI cards. ($130 street; Metabyte Inc., Fremont, CA; 510-494-9700; *www.metabyte.com.*)

STB Systems, soon to be purchased by chip maker 3Dfx Interactive, ironically has a terrific contender in the RIVA TNT–based **STB Velocity 4400.** This 16MB card was the fastest 3D WinMark performer in the roundup, and its 2-D scores were but half a step behind those of the AGP version of the Diamond Monster Fusion. When you add a smooth and easy setup procedure, solid configuration utilities, and a fire-sale price, what's not to like? ($140 street; STB Systems Inc., Richardson, TX; 972-234-8750; *www.stb.com.*)

EDITORS' CHOICE

The Rage Fury card, from ATI Technologies—which wasn't ready in time for this roundup—is expected to include a 128-bit engine, 32MB of SDRAM, dual instruction pipelines, and superscalar architecture that can handle DirectX 6 multitexturing in a single pass. The Rage Fury is reportedly the first mainstream graphics chip to support high-resolution true-color 3-D without a performance hit. Toss in four-tap video filtering and some motion-compensation circuitry and you have the first graphics card with a real DVD-playback assist.—*Jon Hill*

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Dolby Labs Technical Info
www.dolby.com/Tech
The best site for getting the history and details on Dolby Digital and the 5.1-channel surround sound standard.

Aureal A3D
www.a3d.com
Aureal Semiconductor's A3D technology provides the most vivid and realistic digital sound we've heard yet. Peruse this Web site to learn more about how it works.

Creative Labs Environmental Audio
www.soundblaster.com/eaudio
This site explores and explains Creative Labs' EAX 3-D sound technology, which is the main competitor to Aureal's A3D.

Sonera Technology's DisplayMate
www.displaymate.com
DisplayMate is an excellent tool for evaluating, calibrating, and tuning your CRT or LCD monitor. The company's Web site delivers sample test screens and tips on getting the most from your graphics card and monitor.

Today's Powerful Graphics Chips

Today, most accelerators can deliver stunning visual effects and high frame rates in immersive 3-D games while zipping through standard 2-D office tasks without a hitch. The best models stand out for their special quality-enhancement techniques and for features such as DVD video support and bundled LCD controllers.

In recent reviews, we've seen the nVidia RIVA TNT processor edge out the competition on speed tests, thanks to its 128-bit local memory interface and dual 3-D rendering pipelines equipped with flexible texture-mapping engines. It doesn't include hardware-based DVD video support, however. Close on its heels has been the 3Dfx Voodoo Banshee, which runs all GLide games and comes with one of the best VGA cores around.

The Matrox MGA-200 chip produces one of the clearest video signals we've seen, and its excellent 2-D performance is paired with 3-D that's more than ample for business users (though not gamers).

The new ATI Rage 128 chip promises class-leading 3-D performance with support for 32MB of local memory for ultra-high-resolution rendering. Still no word, as of this writing, on the much-anticipated 3Dlabs Permedia 3, with its unusual, efficient texture optimizations and integrated LCD controller.

Less expensive (and less robust) options are also available from S3 and Intel. No matter which chip you buy, be sure to tailor your choice to your own needs—whether you're a gamer or an office user, for instance—while keeping the door open for further upgrades in the future.—*Josh Levy*

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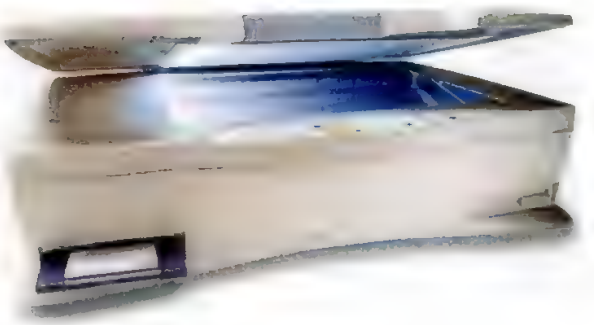

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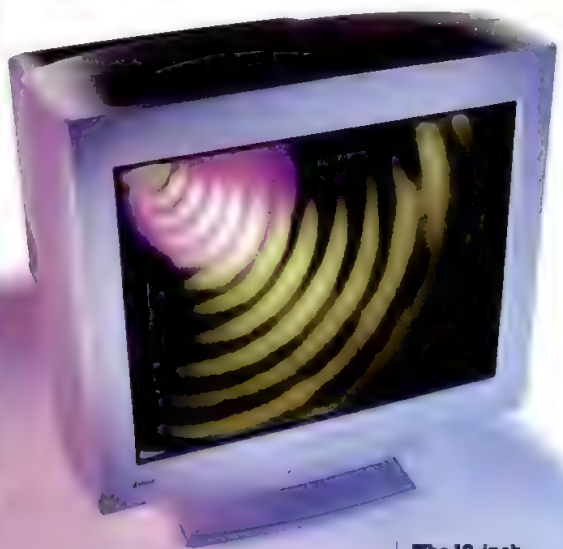
MONITORS

There's one upgrade you can make to your PC that will have absolutely no effect on how fast it runs but will still have a profound effect on your computing experience: buying a new monitor. Today's newest 17- and 19-inch displays provide better image quality than ever before, thanks to narrower dot pitches that enhance sharpness and increased support for high refresh rates to avoid flicker.

For this roundup, we looked at five new flat-faced 19-inch CRTs as well as two existing 17-inch CRTs (one flat-faced and one not). We ran them all through a battery of tests using Sonera Technologies' software DisplayMate (800-932-6323, *www.displaymate.com*), whose customized images highlight particular features and hone in on many image quality problems. When it's time to buy a new display, consider these results as well as what your needs are. If you're a heavy graphics or CAD user, consider a larger, more high-end monitor. If you're primarily an office user, you might opt for something cheaper that can still produce clear text and the refresh rates you need. Gamers will want the biggest screen they can afford; perfect image quality is not a must.



The 19-inch, flat-screen iiyama VisionMaster Pro 450 is a tempting value.

19-INCH MONITORS

As one of the least expensive 19-inch flat-screen CRTs, the **iiyama VisionMaster Pro 450** is a good value. Based on a Mitsubishi Diamondtron NF aperture grille tube (with an aperture pitch ranging from 0.25 mm to 0.27 mm), it has a maximum resolution of 1,600-by-1,200 at an 80-Hz refresh rate. On-screen menus are logical, though an overly short 6-second time-out delay often removes the menus before you've finished making adjustments.

Photos looked sharp in our labs and had accurate colors, though focus patterns in DisplayMate weren't quite as tight as the other monitors'. Color convergence was off just a bit, but this was largely correctable with user controls. Unlike the other units, the VisionMaster Pro doesn't come standard with USB connectivity; it's available as a $100 option. ($700 street; iiyama North America Inc., Costa Mesa, CA; 800-394-4335; *www.iiyama.com.*)

The **Mitsubishi Diamond Pro 900u** gives the most bang for the buck of all the monitors we tested. It's the second-least expensive and has the largest viewable screen size (18 inches). The Diamondtron NF delivers a top refresh rate of 85 Hz at 1,280-by-1,024 and 75 Hz at 1,600-by-1,200.

EDITORS' CHOICE

The Diamond Pro 900u includes an internal USB hub with two upstream and three downstream ports, one of which is on the front panel for quick device connections. A front-mounted button makes it easy to switch between two PCs, either of which can control the monitor via software and an upstream USB connection. On-screen controls are excellent.

During our testing we saw sharp color and screen focus, with only minimally noticeable DisplayMate flaws. ($800 street; Mitsubishi Electronics America Inc., Cypress, CA; 800-843-2515; *www.mitsubishi-display.com.*)

Packed with advanced image control features, the excellent **NEC MultiSync FP950** provides stable and attractive image quality. It has a top resolution of 1,920-by-1,440 at a 73-Hz refresh rate. A button on the front of the display selects between PCs connected to the MultiSync FP950's D-sub and BNC jacks. Image quality is superb, with particularly solid screen-power regulation control, as well as the least noticeable red/blue misconvergence on the sides out of all the CRTs reviewed here. ($900 street; NEC Technologies Inc., Itasca, IL; 800-632-4636; *www.nectech.com.*)

Sony's latest flat-panel CRT monitor, the **Sony GDM-F400,** has the smallest stripe pitch and arguably the best display quality here. The FD Trinitron has a consistent 0.22-mm grille pitch across the screen. The top resolution is 1,600-by-1,200 at 85 Hz, which is further enhanced by the small grille pitch. Additional image control components include the Sony HiDensity Electron Gun with Enhanced Elliptical

UPGRADE TIPS

Monitors

- Don't run the refresh rate faster than necessary; it can degrade image sharpness. Start at the lowest setting and increase the rate until you no longer see flicker in the screen.
- Similarly, don't use a higher color depth than necessary, to avoid fuzziness. For example, if 16-bit color is enough for your applications, don't change your settings to 32-bit.
- Avoid putting your monitor in front of a window or bright light source, to avoid reflections in the screen.
- Adjust your monitor to produce the best possible picture. Increase the brightness so that dark grays are visible, but not so much that true-black backgrounds start to turn gray. To adjust light shades, use the Contrast setting.
- Take frequent "eye breaks" to help reduce eyestrain and fatigue. Alternately focus on objects close to you and on objects as far away as possible.

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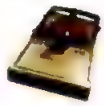
Why should you be buying your business products at Value America? Because we have transformed the awesome potential of Internet commerce into a practical and convenient reality for businesses like yours. You see, we're not an online auction house, flea market, or factory outlet. Our range is not restricted to one or two product categories. We are, rather, a unique and incredibly broad Internet-based source for business equipment and office supplies. Brick & mortar office-supply "superstores" may boast of 7,000 products. We have over four times that—if you don't count the computers and thousands of consumer products. Our secret (aside from hard work and hot technology) is our direct relationship with hundreds of the country's most respected manufacturers: you'll never again get caught in the gray-market whataya-mean-there's-no-warranty  trap. Our dedicated team of business-to-business sales specialists are always there for you. Oh, and one more thing—Value America's prices: always competitive, often the lowest around, and occasionally downright ridiculous.

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The NEC MultiSync E700+ is one of the best bargains in 17-inch monitors.

Correction System and GeoLock Plus circuitry, all to help ensure a smoother and more solid display.

The front panel has an input-source selection button, as well as a joystick-like tool called the DisplayMouse for navigating the on-screen menu. An upstream USB port sits on the back of the monitor, with two downstream ports on each side of the monitor base. In our labs, we saw dead-on image focus with great colors and no noticeable moiré patterning. The GDM-F400 is a terrific choice. ($1,000 street; Sony Electronics Inc., San Jose, CA; 800-352-7669; *www.sony.com/displays.*)

A very fine, well-thought-out monitor, the **ViewSonic PT795** boasts a maximum resolution of 1,920-by-1,440 at 73 Hz, but images looked better to us at 1,600-by-1,200 (at 87 Hz) and 1,280-by-1,024 (at 101 Hz). USB connectivity consists of one upstream and four downstream ports, with two of each on the left side and two of each on the right. There are two menu buttons for on-screen image controls, one for the full set of controls and one for just brightness and contrast—a convenient grouping.

During DisplayMate testing, the ViewSonic revealed only minor moiré patterning, which was controllable with the on-screen image adjustments. Color convergence was excellent, and focus was very good, though we noticed minor frame pulsing during full-screen power regulation tests. ($1,000 street; ViewSonic Corp., Walnut, CA; 800-888-8583; *www.viewsonic.com.*)

17-INCH MONITORS

With its PureFlat stripe-mask tube, the **Panasonic PanaFlat PF70** is competent but suffers from some noticeable image flaws. Though billed as a high-end monitor, its performance doesn't justify the price premium for the flat screen. With a stripe pitch of 0.24 mm and a viewable area of 15.9 inches, the PanaFlat PF70 is capable of resolutions of up to 1,600-by-1,200 at a 69-Hz refresh rate. It can also handle 1,024-by-768 resolution at up to 106 Hz.

In our labs, colors weren't as crisp as on some other monitors, and there was some noticeable discoloration at the edges of the screen on the color-purity tests. At 1,024-by-768, single-pixel vertical lines were thinner than horizontal ones, and there were some small convergence errors along the left edge. On the other hand, the moiré controls were extremely effective, and the screen geometry and image regulation were excellent. ($680 street; Panasonic Computer Co., Secaucus, NJ; 800-742-8086; *www.panasonic.com/alive.*)

The **NEC MultiSync E700+** isn't a flat-screen CRT, but as a past Editors' Choice in this monitor size, we include it for comparison purposes. Its image quality should suit most mainstream business needs, and it's a good deal for the price. With a diagonal viewable size of 15.6 inches, a 0.25-mm stripe pitch, and an NEC-made CromaClear Invar shadow mask, it's capable of up to 1,600-by-1,200 at 65 Hz. It can also generate an 85-Hz refresh rate at 1,024-by-768.

During our testing, color uniformity was good, and vertical and horizontal lines appeared to have equal thickness. Convergence and screen geometry were excellent. The monitor's only major weakness was strong moiré patterns and no controls available to counter them. ($500 street; NEC Technologies Inc., Itasca, IL; 800-632-4636; *www.nectech.com.*)

THE LCD OPTION

If budget is less of a constraint, you may want to consider an LCD monitor as an upgrade. These displays weigh just a fraction of a CRT of similar diagonal screen size and take up much less desk space. They also provide breathtakingly sharp images. On the downside, they work best at one resolution (because each pixel is addressed directly), they cannot produce as rich a range of colors in general, and they do not provide as wide a viewing angle when you're not looking directly into the screen.

If you want the best image quality in a flat monitor, consider getting one with a digital interface. A few graphics adapters are designed to work with both digital and analog monitors, but it is likely that your existing system does not include this feature, so you will also need to upgrade your graphics adapter. Plan on spending $1,500 to $2,000 for a 15-inch digital-interface LCD monitor (roughly equivalent in actual viewable screen size to a 17-inch CRT display) and $3,000 for an 18-inch LCD (equivalent to a 19-inch CRT).

You can also get 15-inch LCD monitors for less than $1,000, but these use an analog interface. This means they can attach to the same graphics adapter as your existing CRT monitor, but the images are not as crisp and clear as you'll find with a digital interface panel.—*Bruce Brown and Alfred Poor*

The 17-inch Panasonic PanaFlat PF70 was disappointing for the price.

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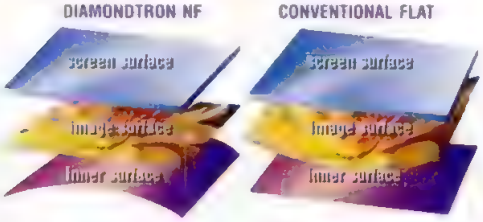

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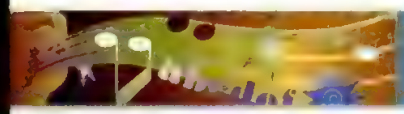

SOUND CARDS

It wasn't too long ago that standalone sound boards looked like an endangered species, thanks to new integrated sound chips appearing on PC motherboards. Then along came DirectSound3D (DS3D), a key component of Microsoft's DirectX API suite that defined a standard way to position sounds in 3-D space above, below, or even behind the listener. The industry quickly embraced the new standard, making positional 3-D sound effects this year's hottest new feature and making 3-D chip sets the hottest addition to new sound cards, especially for playing games and listening to—or writing—music.

The most sophisticated technology is Aureal Semiconductor's A3D 2.0, which runs off the company's Vortex 2 processor. A3D's Wavetracer function creates a physical model of an acoustic environment, including reflective surfaces, variable sound sources, and a number of other effects that simulate sound coming from around corners, through walls, and across distances. A competitor is Creative Labs' EAX, which, though less advanced, compensates by bundling a variety of special enhancement features, including a number of preset acoustic environments.

Another factor helping jump-start sound technology is the increasing popularity of DVD. Playing a 5.1-channel DVD soundtrack requires a system with either a built-in Dolby Digital decoder and six speaker outputs, or a digital output that can send raw data to an off-board decoder. This has resulted in a new generation of PCI boards that use powerful accelerator chips and often provide digital I/O and 4-channel analog speaker ports. Despite all this complexity, setting up the new boards is a breeze, thanks to the PCI bus's rapidly maturing plug-and-play capabilities. And upgrading to a new accelerator can be surprisingly inexpensive.

For this roundup, we tested four popular sound cards on a 266-MHz Pentium II PC with 32MB of RAM, running Microsoft Windows 98. To test performance—especially in 3-D—we ran Audio WinBench 99 and a few canned videos from vendors.

CREATIVE LABS SOUND BLASTER LIVE!

The one card we tested that costs more than $100 is the Creative Labs Sound Blaster Live! ($200 street). But the price is easy to justify. Resting atop the main board, which is equipped with four speaker outputs, is a secondary breakout card that consumes one backplane space but no slots. The card adds S/PDIF (short for *Sony/Philips Digital Interface*) input and output ports, a digital DIN connector for 5.1-channel systems, and mini-DIN jacks that let you attach a joystick and an external MIDI module. Documentation is excellent, and installation took us only 10 minutes. The card's EAX sound technology generated convincing positional effects.

On our 266-MHz Pentium II test-bed, Audio WinBench 99 reported only 10 percent CPU utilization while the board was playing 32 simultaneous high-overhead 44.1-kHz DS3D audio streams. It reported a mere 1.5 percent utilization when the board played 32 standard DirectSound streams. The 64-voice hardware synth produced acceptable sound, and the software synth generated accurate MIDI.

Despite its higher price, the Sound Blaster Live!'s over-the-top feature set and software bundle make it a good choice for just about any sound-processing task. ($200; Creative Labs Inc., Milpitas, CA; 800-998-5227; *www.sblive.com.*)

DIAMOND MONSTER SOUND MX300

The latest from Diamond Multimedia has fewer bells and whistles than the Sound Blaster Live!, but in many ways it's more impressive. In addition to four-channel output, a generous software bundle, and foolproof setup routines, the **Monster Sound** boasts some of the most powerful MIDI and 3-D we've seen. Its Aureal Vortex 2 chip can accelerate up to 96 DirectSound and 16 DirectSound3D audio streams and provides a 320-voice synthesizer that produces smooth, detailed General MIDI and Roland GS output.

The Monster Sound supports a broad selection of algorithms—including DS3D, A3D, and EAX—plus MPEG-3 encoding and playback and the DOS-based Sound Blaster Pro standard. Its Dolby Digital and software MPEG features can remix 5.1-channel DVD sound tracks for four-speaker playback, and an optional daughterboard, which should be shipping by the time you read this, will add S/PDIF I/O for true six-speaker Dolby Digital output.

Our only beef is the card's high CPU utilization. It used over 7 percent of the CPU's resources to render 32 DirectSound voices and consumed a whopping 60 percent when playing 32 DirectSound3D voices. ($100; Diamond Multimedia Systems Inc., San Jose, CA; 800-468-5846; *www.diamondmm.com.*)

UPGRADE TIPS

Sound Cards

- Buy PCI, not ISA. Even plug-and-play ISA sound boards can be torture to set up, and virtually all of the latest sound chips require PCI to deliver top performance.
- If you expect to use your PC to play DVDs with Dolby Digital 5.1-channel sound, choose a card with an S/PDIF digital output. You'll need it to drive your multichannel surround-sound speaker system.
- Be sure your computer's chassis has enough room to hold your new sound board. Many new boards consume two backplane spaces, and others require an optional breakout card or daughterboard to add functions such as digital I/O or four-speaker output.
- Don't assume you'll be able to reuse the CD audio cable currently plugged into your motherboard. Many older motherboards aren't furnished with today's standard CD connectors—a must for the latest sound cards. If you need one, check the board vendor or a local computer parts store.
- Choose a board that off-loads processor-intensive tasks to a sound-processing chip, such as the Aureal Vortex 2 or the E-mu EMU10K1. Why spend money on a new upgrade card that will only slow down your machine?

You want to e-mail.
He needs to download.
She'd like to surf.
Who will be left standing?
intel inside
pentium II

PRESARIO 5600i-450	COMPAQ PRESARIO 5600i-450	COMPAQ PRESARIO 5600i-450	COMPAQ PRESARIO 5600i-400	COMPAQ PRESARIO 5600i-400
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DRAM expandable to 384 MB	128 MB SyncDRAM expandable to 384 MB	128 MB SyncDRAM expandable to 384 MB	128 MB SyncDRAM expandable to 384 MB	64 MB SyncDRAM expandable to 384 MB
DMA Hard Drive	13.0 GB UltraDMA Hard Drive	13.0 GB UltraDMA Hard Drive	10.0 GB UltraDMA Hard Drive	13.0 GB UltraDMA Hard Drive
Drive*	32X Max CD-ROM Drive*	6X DVD-ROM Drive*	32X Max CD-ROM Drive*	6X DVD-ROM Drive*
r 550 AGP w/16 MB SDRAM	2X AGP Graphics w/8 MB SGRAM	2X AGP Graphics w/8 MB SGRAM	2X AGP Graphics w/8 MB SGRAM	2X AGP Graphics w/8 MB SGRAM
ister Sound MX300 PCI Audio Card	Aureal 8820 PCI Audio Card	Aureal 8820 PCI Audio Card	Aureal 8820 PCI Audio Card	Aureal 8820 PCI Audio Card
igital Modem*	56K ITU V.90 Modem	56K ITU V.90 Modem	1.5Mb Max Digital Modem*	56K ITU V.90 Modem
ium Speakers w/Subwoofer	JBL Pro Speakers	JBL Pro Speakers	JBL Pro Speakers	JBL Pro Speakers
ity Imaging Center*	Digital Creativity Imaging Center*	Digital Creativity Imaging Center*	Home Phoneline Networking™ for 2 computers**	Home Phoneline Networking™ for 2 computers**
rnet Port, Cable Modem Ready	10 Mbps Ethernet Port, Cable Modem Ready	10 Mbps Ethernet Port, Cable Modem Ready	10 Mbps Ethernet Port, Cable Modem Ready	10 Mbps Ethernet Port, Cable Modem Ready
tured Home Collection & MS® Word	Microsoft Office 97 Small Business Edition	Microsoft Featured Home Collection & MS Word	Microsoft Office 97 Small Business Edition	Microsoft Featured Home Collection & MS Word
dows98	Microsoft Windows98	Microsoft Windows98	Microsoft Windows98	Microsoft Windows98
19" Monitor (18.0" VIA)	Compaq V910 19" Monitor (18.0" VIA)	Compaq V720 17" Monitor (15.9" VIA)	Compaq V720 17" Monitor (15.9" VIA)	Compaq V720 17" Monitor (15.9" VIA)
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o w/Dual Subwoofers (160 watts)	Iomega Zip Built-in™ Drive Add $79	Diamond Monster Sound MX300 PCI Audio Card & JBL Pro Premium w/Subwoofer: Add $89	Iomega Zip Built-in™ Drive Add $79	Compaq V910 19" Monitor (18.0" VIA) Add $170
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ive Matrix Display	13.3" TFT Active Matrix Display	13.3" TFT Active Matrix Display	14.1" TFT Active Matrix Display	14.1" TFT Active Matrix Display
DRAM expandable to 192 MB	128 MB SyncDRAM expandable to 192 MB	64 MB SyncDRAM expandable to 192 MB	96 MB SyncDRAM expandable to 192 MB	64 MB SyncDRAM expandable to 192 MB
MA Hard Drive	6.4 GB UltraDMA Hard Drive	4.0 GB UltraDMA Hard Drive	6.4 GB UltraDMA Hard Drive	6.4 GB UltraDMA Hard Drive
on DVD-ROM Drive	2nd-Generation DVD-ROM Drive	2nd-Generation DVD-ROM Drive*	24X Max CD-ROM Drive	2nd-Generation DVD-ROM Drive
Accelerated Graphics w/2.5 MB VRAM	256-bit AGP Accelerated Graphics w/2.5 MB VRAM	256-bit AGP Accelerated Graphics w/2.5 MB VRAM	256-bit AGP Accelerated Graphics w/2.5 MB VRAM	256-bit AGP Accelerated Graphics w/2.5 MB VRAM
Modem*	56K ITU V.90 Modem	56K ITU V.90 Modem	56K ITU V.90 Modem*	56K ITU V.90 Modem*
attery	Smart Lilon Battery	Smart Lilon Battery	Smart Lilon Battery	Smart Lilon Battery
ated "On-chip" cache	256 KB Integrated "On-chip" cache	256 KB Integrated "On-chip" cache	256 KB Integrated "On-chip" cache	256 Integrated "On-chip" cache
Small Business Edition	MS Featured Home Collection	MS Featured Home Collection	MS Office 97 Small Business Edition	MS Office 97 Small Business Edition
dows98	Microsoft Windows98	Microsoft Windows98	Microsoft Windows98	Microsoft Windows98
299	**$2,999**	**$2,499**	**$2,999**	**$2,849**
DMA Hard Drive:* Add $350	Port Replicator: Add $129	6.4 GB Ultra DMA Hard Drive:* Add $100	192 MB SyncDRAM: Add $250	192 MB SyncDRAM: Add $150
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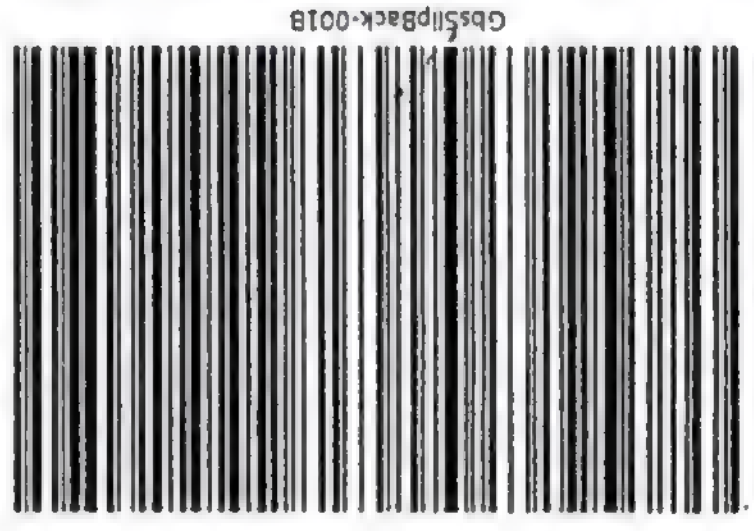


Back

1. Follow instructions on the other side

Inverted Back

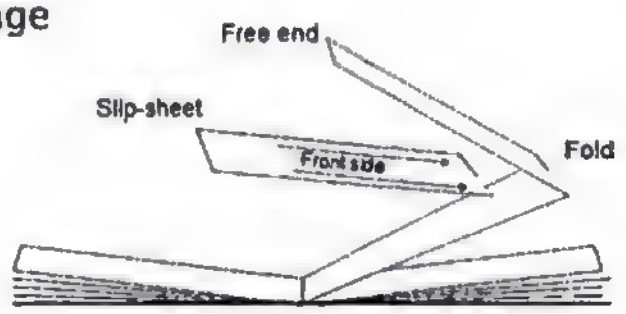
1. Follow instructions on the other side

Folded edge of the page

GbsSlipSheet-001

Inverted Foldout slip-sheet

1. Open the foldout page
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



Foldout slip-sheet

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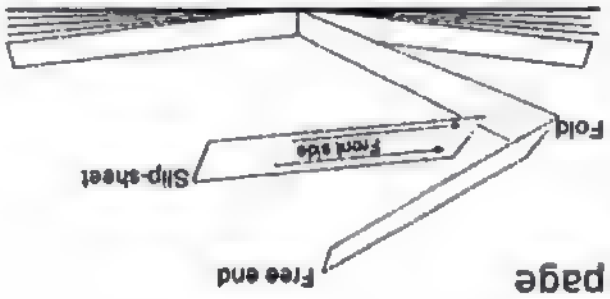
2. Insert this sheet with
   1. Front side touching the free page
   2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet



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2X AGP Graphics w/8 MB SGRAM	Diamond Viper 550 AGP w/16 MB SDRAM
Aureal 8820 PCI Audio Card	Aureal 8820 PCI Audio Card
56K ITU V.90 Modem[2]	56K ITU V.90 Modem[2]
JBL Pro Speakers	JBL Pro Premium Speakers w/Subwoofer
10 Mbps Ethernet Port, Cable Modem Ready	10 Mbps Ethernet Port, Cable Modem Ready
Microsoft® Office 97 Small Business Edition	Microsoft Featured Home Collection & MS Word
Microsoft Windows®98	Microsoft Windows98
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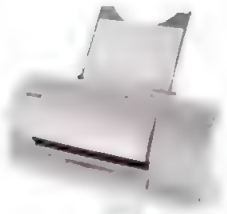

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pentium II

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TURTLE BEACH MONTEGO II A3D

The Turtle Beach Montego II A3D looks like the Monster Sound, and both are dominated by Aureal Vortex 2 chips. Not surprisingly, the Montego matches the Monster Sound's awesome 320-voice synth and dazzling A3D positional effects. The Montego's 18-bit DACs provide greater dynamic resolution than the 16-bit ones on other boards, and it renders DS3D more efficiently. CPU utilization is a bit high, however, and the direct-purchase version lacks Dolby Digital and MPEG-3 encoding, doesn't support Roland GS MIDI, and ships with ho-hum software.

By the time you read this, Turtle Beach hopes to release a similarly priced consumer-gaming version equipped with bidirectional digital I/O, two more speaker ports, and a heftier software bundle. ($100; Voyetra Turtle Beach Inc., Yonkers, NY; 800-233-9377; *www.tbeach.com.*)

YAMAHA WAVEFORCE 192 DIGITAL

The Yamaha WaveForce 192 Digital is the lowest-priced accelerator we've seen with digital-output capabilities, but it can accelerate only eight simultaneous DirectSound3D voices, resulting in high CPU utilization on DS3D titles (66 percent when playing 32 44.1-kHz voices). It lacks 4-channel output, and its minipin digital-output is problematic, requiring an adapter to work with RCA-style S/PDIF ports.

Most frustrating is the WaveForce's three-synthesizer MIDI implementation. A flexible, 64-voice hardware synth supports General MIDI, Roland GS, and XG patch sets. Yamaha's S-YXG50 general-purpose software synth adds another 128 voices, but wind instruments are played by a different software synth that uses physical modeling. In hands-on testing, hardware voices sounded fine but many patches were distant and cramped, and the physical-modeling synth often generated distortion.

The WaveForce does include a competitive software bundle and 3-D spatialization capabilities. It also supports DS3D, A3D 1.0, and CRL's Sensaura 3-D sound technology, which can move sounds disorientingly close to your ear. ($100; Yamaha Corp. of America., Buena Park, CA; 714-522-9011; *www.yamaha.com.*)—*Don Labriola*

SPEAKERS

Upgrading your PC's speaker system used to be pretty straightforward: You simply looked for a model with the highest power ratings and the heftiest subwoofer you could afford. These days it's not so simple. Late-breaking technologies—such as flat-panel drivers, USB digital sound, and multichannel surround audio—have generated all sorts of exotic new designs. At the same time, the latest generation of traditional analog desktop speakers sound better and cost less than ever before.

ANALOG SYSTEMS

A fine traditional model is the **Altec Lansing ACS45.1.** Combining the familiar ACS43 PowerCube satellites with a powerful new bass module, it's a good all-around performer with high volume levels and a solid low end, despite ho-hum clarity, spaciousness, and imaging—and a boomy subwoofer. But it lacks major flaws and delivers exactly the kind of sound many users want at an affordable price. ($79 list; Altec Lansing Technologies Inc., Milford, PA; 800-258-3288; *www.altecmm.com.*)

The Bose MediaMate is a great sound system for those who don't need a lot of heavy bass.

The **Bose MediaMate** is a terrific two-piece system. Transparent, uncolored, and with a high end that seems to go on forever, it produces breathtaking sound; the only flaw is its lack of a bass unit, which reduces dynamic range and virtually eliminates output in the lowest registers. ($200 street; Bose Corp., Framingham, MA; 800-444-2673; *www.bose.com.*)

Far less appealing is the three-piece **Boston Acoustics MicroMedia.** Its tiny satellites and underpowered bass unit never get loud and produce muddy, veiled sounds. Imaging is also rather poor. ($149 list; Boston Acoustics Inc., Peabody, MA; 877-333-4001; *www.bostondirect.com.*)

The classic three-piece **Cambridge SoundWorks** system is no longer head and shoulders above the competition, but its perfectly matched components produce smooth musical output and a tight low end. Throw in the $50 rebate and it's still a contender. ($99.99 list, after $50 rebate; Cambridge SoundWorks Inc., Newton, MA; 800-367-4434; *www.hifi.com.*)

A more impressive system is the three-piece **InterAct Advent Powered Partners AV290,** with its startling clarity, spaciousness, and imaging. Its wall-mountable subwoofer generates superb upper-level and midlevel bass. A badly designed power-saving sleep mode frequently mutes the first half-second of playback, and the satellites' poor shielding can cause monitor interference. But from a purely sonic standpoint, it's stunning. ($100 street; InterAct Accessories Inc., a division of Recoton Corp., Lake Mary, FL; 407-333-1392; *www.poweredpartners.com.*)

EDITORS' CHOICE

The three-piece **Labtec APX-4620**'s large subwoofer generates amazing wall-shaking bass. Despite a slightly veiled high end, the midrange is spacious, and the integrated Spatializer 3-D sound enhancement is downright bombastic. ($114 list; Labtec Inc., Vancouver, WA; 360-896-2000; *www.labtec.com.*)

USB SYSTEMS

The biggest problem with the above speakers is that they run off the relatively noisy analog signals generated by your computer's CD player or sound board. One solution is to upgrade to a digital system, which

SONY

By all means, think outside the box. Just put it all back when you're done.

www.sony-hifd.com

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UPGRADE TIPS

Speakers

- Speakers with similar features can sound very different, so read reviews, audition friends' systems, and patronize only stores that let you listen before you buy.
- Experiment with placing your speakers around the room. Position the satellites so that a mono signal appears to be at dead center, and move the subwoofer closer to a back wall to increase the bass.
- Don't buy a USB speaker unless you're running Windows 98. Windows 95's USB audio drivers can't stream digital audio over the USB bus.
- When buying a multichannel speaker system, make sure your sound board has the correct outputs. You'll need a digital S/PDIF output for 5.1 channels.

accepts virtually noise-free input through the USB bus. USB speakers also offer nifty features like on-screen menus and bundled sound applets. But installation can be complicated, requiring you to load multiple drivers and utility software. They also have stringent system requirements, including Windows 98 and a CD player that can stream digital audio.

One of the first USB models on the market was the **Altec Lansing Digital PowerCube ADA70,** a three-piece system with the same bass module as the ACS45.1. Its minimal USB features merely add volume and tone controls to the standard Windows mixer, and its sound quality suffers from a mediocre high end, fuzzy imaging, and limited volume. ($129 list; Altec Lansing Technologies Inc., Milford, PA; 800-258-3288; *www.altecmm.com.*)

The Sonigistix Monsoon flat-panel system produced amazingly clear sound.

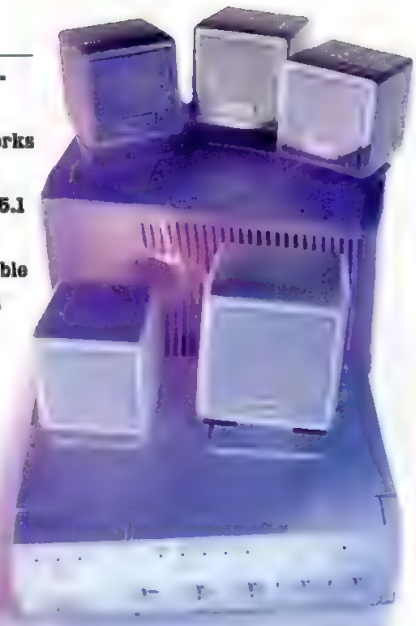
A more robust USB system is the **Microsoft Digital Sound System 80,** which includes spiffy ten-band equalizer software, 3-D sound enhancement, and on-screen versions of all its physical controls. Installation was hampered by several crashes, but we gritted our teeth and kept rebooting until the self-configuring USB drivers got everything right. Sound quality was awesome, with high volume levels, a detailed spacious midrange, and tight, authoritative bass. ($192.50 list; Microsoft Corp., Redmond, WA; 800-426-9400; *www.microsoft.com/speakers.*)

FLAT-PANEL SPEAKERS

Another neat new desktop technology is the flat-panel driver. Once restricted to audiophile home systems, these wafer-thin devices radiate sound in a straight line rather than in a hemisphere like conventional cone drivers. Their light weight and low excursions provide superior high-frequency performance, and they have enough surface area to match the bass response of larger cones.

The **Kwong Benwin Flat Panel BW2000** has flat-panel satellites that each consist of a small vibrating exciter disk attached to a 5- by 7-inch sheet of rigid plastic. Alas, the design is seriously flawed, resulting in limited volume and almost no high end or imaging. Even worse is the barely audible cone subwoofer, which we drove into gross distortion by adjusting the tone controls. ($129 list; Kwong Quest LLC, City of Industry, CA; 888-923-6946; *www.benwin.com.*)

More successful is the striking **Sonigistix Monsoon MM-1000 Multimedia Speaker System,** which includes 4- by 8-inch flat satellites designed with the same paper-and-magnets technology used in conventional cones. Despite a slightly rolled-off high end, this uncolored system produced decent volume and fine transparency. Its subwoofer also provided solid upper and middle bass. ($199 list; Sonigistix Corp., Little Rock, AR; 877-722-8346; *www.monsoonpower.com.*)



The Cambridge SoundWorks DeskTop Theatre 5.1 delivers remarkable surround sound.

DOLBY DIGITAL SYSTEMS

The DVD industry hasn't yet hit its stride, but it has already begun to spawn desktop surround-sound systems that support the Dolby Digital 5.1-channel format (five full-range speakers and one subwoofer). Most include Dolby Digital decoders, and many are compatible with older surround technologies like Dolby Pro Logic. But they need PCs with appropriate software and either multichannel analog outputs or digital I/O connectors for surround effects.

The **Cambridge SoundWorks DeskTop Theatre 5.1** is the best-sounding 5.1-channel system today. It includes four tiny Cambridge PC Works satellites, one larger SoundWorks center-channel satellite, an off-board decoder, and a PC Works subwoofer. Installation is straightforward, though routing the system's maze of cabling took us close to an hour. At higher volumes, the system's high end became harsh and its subwoofer petered out, but at moderate volumes, it filled the room with beautifully uncolored, detailed sound. The easy-to-use decoder accepts Dolby Digital, Pro Logic, and analog signals and can even process two- or four-channel analog input for six-speaker playback. ($299 list; Cambridge SoundWorks Inc., Newton, MA; 800-367-4434; *www.hifi.com.*)—*Don Labriola*

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DVD UPGRADE KITS

If you're thinking about upgrading an aging CD-ROM drive, be sure to replace it with a DVD-ROM or DVD-RAM kit. These drives play all previous CD formats as well as the new DVD movie, game, and edutainment titles. Though more expensive, a DVD-RAM drive also serves as a removable-storage drive (for backups and the like) with a generous 4.6GB of (formatted) capacity per cartridge. And the newest 2X DVD drives can move data at up to 2.6 MBps, which is equivalent to the speed of a 16X CD-ROM drive.

For this roundup, we looked at four DVD kits. Each includes a hardware MPEG-2 decoder card that lets you use the drive to watch movies. Note that some manufacturers believe there's sufficient surplus processing power in a high-end desktop PC for decoding MPEG-2 movies in software. To find out how practical this approach is, we ran in-house tests comparing software decoding against hardware decoding on two base machines—an NEC Pentium II/300 and a Dell Pentium II/400. Each used the Matrox Millennium G-200 AGP graphics card, which is compatible with software DVD via a $10 online purchase.

We performed our evaluations using movies such as *Twister* and the test disk that accompanies Jim Taylor's book *DVD Demystified*. With software DVD decoding, we saw startlingly jumpy scenes with lots of tearing and color shifting. Hardware DVD, using the Creative Labs kit (reviewed below), was satisfactory.

All four kits in this group share some similar features. For example, all use PCI-based decoding cards with analog video overlay for displaying DVD images on your PC's monitor, along with automatic adjustment, which makes configuration easy. All also offer composite and digital audio output.

The **Creative Labs PC-DVD Encore 5x** is the best of the bunch. It includes a Matsushita-made DVD-ROM drive and Creative Labs' own decoder card for MPEG-2 playback. The card relies on the company's *DynamicXtended Resolution Technology* (Dxr2), which is designed to permit scaling of images to higher resolutions without artifacts at up to 1,280-by-1,024 at 24-bit color depth. We didn't test the board at that resolution, but we did notice fewer scaling artifacts on a full 1,024-by-768 screen than with the REALmagic card in the other kits reviewed here. The software interface resembles a typical home-entertainment remote control. Although this isn't as full-featured as the REALmagic interface, it worked well.

On our benchmark tests, the Encore was the fastest of this group in terms of CD access time, at 106 milliseconds, and it had one of the fastest CD-ROM transfer rates, at almost 20X (2,966 KBps). On the DVD throughput test, the transfer rate ranged to about 2.5X (specifically to 3,815 KBps), which didn't match the company's claims but was still fast for this roundup.

Decoded video images were excellent, with fine details preserved and no obvious motion artifacts. There was only a small amount of shimmer in finely textured areas. The only significant problem was that the wide-screen aspect ratio of 16:9 was squeezed horizontally when we scaled the image to full-screen, but this wasn't a problem when we viewed the image in an unscaled window. For its price and performance, the Creative Labs PC-DVD Encore 5x is the one to beat. ($250 street; Creative Labs Inc., Milpitas, CA; 800-998-5227; *www.soundblaster.com.*)

The $500 **Hi-Val DVD-RAM** offers all the playback advantages of the other kits in this roundup, plus the benefit of a read/write storage device you can use for backup and near-line storage. The bundled Toshiba DVD-RAM drive is the

How to Install a DVD Drive

BEFORE YOU START

Lightly touch your PC's metal chassis to discharge any current from your body. Then unplug the power cable.

WHAT YOU'LL NEED

1 ▼ TURN OFF YOUR COMPUTER AND OPEN THE CASE. Locate an available PCI slot for the MPEG-2 decoder card (if your kit includes one). If you're installing a SCSI drive and you don't yet have a SCSI controller in the system, you'll need a second slot for the SCSI card.

2 ▶ REMOVE THE END BRACKET for the selected slot, insert the card, and secure the card's own end bracket.

3 ▲ LOCATE AN AVAILABLE 5.25-INCH DRIVE BAY that opens onto the front of the case. Remove the bay cover if necessary.

only SCSI-2 device among the four kits reviewed here, and it's packaged with an Adaptec 2940 controller card.

We were disappointed to find that the kit ships without the jumper required for making DVD-RAM functions available. The sparse documentation does show how to add the jumper—once you obtain one or locate one in your spare-parts drawer—but this is an unnecessary complication.

Once we added the jumper, installation proceeded smoothly, and it was easy to format the DVD-RAM media quickly. (The formatted media provides 2.3GB per side.) The kit includes the same REALmagic decoder card as the other Hi-Val kit, and movie results were nearly identical. On speed tests, the media produced a maximum CD transfer rate of about 12X (1,806 KBps); the rate was just shy of 2X for DVD (2,730 KBps).The Hi-Val kit is rough around the edges and lacks the polished documentation you'll find with some other kits, but it works well once you get it running. ($500 street; Hi-Val Inc., Santa Ana, CA; 714-953-3000; *www.hival.com.*)

Hi-Val's third-generation DVD-ROM upgrade kit, the **Hi-Val DVD-3,** is a fine product that nevertheless falls short of the Creative Labs entry on price and performance. It comes with a Toshiba IDE DVD-ROM drive and a REALmagic decoder card whose software interface resembles the front panel of a VCR, so you can easily take advantage of different DVD movie features, including different-language sound tracks and subtitles.

During testing, the Toshiba drive exceeded the claimed speeds, reaching about 22X for CD-ROM (3,383 KBps) and about 2.5X for DVD-ROM (3,785 KBps). On movie tests, there was some small but noticeable jitter along the left and right edges of the image window in all cases. Continuous-tone areas (such as close-ups on faces) tended to posterize slightly, and there was noticeable shimmer in textured surfaces. There were no motion artifacts in unscaled windows; but when we enlarged images to full-screen, there was some evidence of comb effects on the leading edges of moving objects, as well as more pronounced shimmer on textured surfaces. ($280 street; Hi-Val Inc., Santa Ana, CA; 714-953-3000; *www.hival.com.*)

The **NewCom Cinema II Plus DVD Multimedia Kit** closely resembles the Hi-Val DVD-3. It's a well-designed product that will please many users, but it's not up to the standard of the Creative Labs kit. It comes with a Hitachi IDE drive and the same PCI-based REALmagic decoder card as in the Hi-Val kits.

The Cinema II performed similarly to the Hi-Val DVD-3, including posterization in continuous-tone areas, some shimmering in textured areas, and some scaling and motion artifacts when the image was zoomed to full-screen. On our speed tests, the drive reached 14X for CD (2,198 KBps) and almost 2X for DVD (2,620 KBps). ($230 street; NewCom Inc., Westlake Village, CA; 800-563-9266, 818-597-3200; *www.newcominc.com.*)—*Alfred Poor*

UPGRADE TIPS

DVD

- DVD movies are encoded for different world regions; be sure to configure your MPEG-2 decoder card for yours. The United States and Canada are in region 1.
- If you're installing a new IDE drive and this is the first time you've ever used your PC's secondary IDE connection, make certain the connection is activated in your system BIOS.
- If you're using a SCSI drive and there are other devices on the SCSI chain, make sure to assign the drive a unique ID and to terminate the chain correctly (only at its two ends, when you have added the new drive).
- Computer monitors have better resolution than standard televisions, so to get the most out of the improved image quality of DVD movies, watch them on your monitor.
- For the full DVD movie effect, get a sound system that accepts digital audio input and can process Dolby Digital surround sound (also known as *5.1-channel sound*).

4 ▼CONFIGURE THE JUMPERS ON YOUR DVD DRIVE. For an IDE drive, set the jumpers for either *master, slave,* or *sole drive,* depending on what else is on the channel. For a SCSI drive, set the jumpers to the correct ID or termination setting.

5 ▼SECURE THE DRIVE IN THE BAY.

6 ▼ATTACH THE CABLES. Connect the DVD drive to the IDE or SCSI bus and to the power supply. Also connect the DVD drive to your sound card—or connect the decoder card (if included) to the DVD drive and sound card. (If you already have a CD-ROM drive, you can use a micro stereo patch cord to connect the external headphone jack on the DVD drive to your sound card's line-in jack.)

7 ▼CLOSE THE CASE, turn on the power, and install any necessary drivers or software.

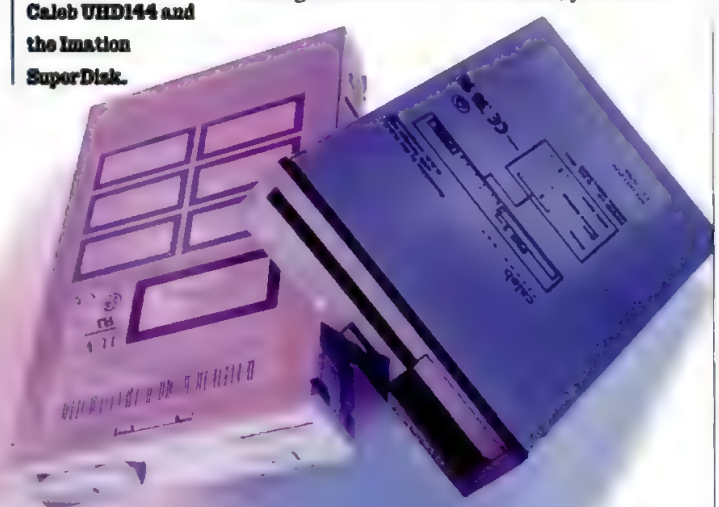
FLOPPY DISK DRIVES

If you're looking for a higher-capacity upgrade to your floppy disk drive, there's a wealth of alternatives to choose from. For this story we looked at four of the market's most viable options, each of which uses a different format. Most of these drives come in several configurations, usually parallel-port, internal IDE, and internal SCSI. In our labs, we tested IDE versions of all of them except for the Sony HiFD, which at the time of this writing is available only in a parallel-port model.

Physical installation is essentially identical for all four IDE drives: Set the jumpers for *master, slave,* or *sole drive;* mount the drive in a bay; and connect the power and data cables. You can then boot up and use any of these drives immediately, at least in Microsoft Windows 98.

The rather obscure but competent **Caleb UHD144** offers 144MB capacity as well as backward compatibility with traditional floppy disks. The drive fits into either a 3.5-inch bay or a 5.25-inch one via a special mounting kit (sold separately). Windows 98 and NT 4.0 recognize the UHD144 automatically, but as a precaution it comes bundled with a disk of drivers for DOS, Windows 3.*x*, 95, and 98, and Windows NT 3.51. On our tests, the UHD144's performance was a distant second to the Iomega Zip Drive and only a little better than the Imation SuperDisk, which was faster when reading but slower when writing to disk. ($80 street; three disks, $15.99 list; Caleb Technology Corp., Boulder, CO; 303-786-9600; *www.caleb-bldr.com.*)

The **Imation SuperDisk** uses the LS-120 format, which has a 120MB capacity and full support for standard 1.44MB and 720K floppy disks. Like the Caleb unit, it fits in a 3.5-inch bay, but the SuperDisk includes a mounting kit for a 5.25-inch bay. The package comes with a set of utilities, including an accelerator application that caches to your hard disk. On speed tests without caching, the SuperDisk came in second out of the three functioning super-floppy disk drives. The LS-120 format is becoming more popular, especially with laptop makers, and Imation reportedly will be releasing a 250MB version of the SuperDisk around midyear. ($130 street; 10 disks, $100; Imation Corp., Oakdale, MN; 888-466-3456; *www.superdisk.com.*)



Iomega's competitors—the Caleb UHD144 and the Imation SuperDisk.

A different business model is at work behind the 100MB **Iomega Zip Drive,** which earns our Editors' Choice for its performance and ubiquity. Instead of using the Zip to replace floppy disk drives through backward compatibility, Iomega sees the two drive types coexisting, much the way 3.5-inch drives coexisted on the same systems as 5.25-inch drives for years. And with the largest installed base of all these drives (16 million users), it's the unit of choice—for now at least—for exchanging files.

The Zip will fit in a 3.5-inch bay but also comes with a 5.25-inch mounting kit, along with utilities for such basic operations as disk formatting. As our tests show, it offers the best performance in the group, which goes a long way to making up for its relatively low capacity. Important note: A 250MB version should be available by the time you read this. ($100 street; 10 disks, $100; Iomega Corp., Roy, Utah; 800-697-8833, 801-332-1000; *www.iomega.com.*)

The **Sony HiFD** offers a 200MB capacity and can read and write to 1.44MB and 720K floppy disks. Physical setup for the external model consists of plugging in a power cord and a parallel cable, and optionally plugging your printer into the pass-through connector. In addition, you need to install a driver from a floppy disk (for Windows 3.*x*, 95, 98, NT 4.0, or DOS). Alas, we can't say anything about performance, because the test unit was defective, and Sony was unable to provide a replacement in time for review. ($199 list; three disks, $39.99; Sony Electronics Inc., San Jose, CA; 800-352-7669, 408-432-1600; *www.sony.com/storagebysony.*)

Another viable option for sharing and storing large files is a compact disk–recordable (CD-R) or compact disk–rewritable (CD-RW) drive. Such devices are available from a number of manufacturers, and they will let you share large files with any computer user with a CD-ROM or DVD-ROM drive. They offer 650MB storage on either write-once CD-R disks ($2 each) or reusable CD-RW media ($12), and you can create audio CDs. They do need a 5.25-inch bay for installation, however, and they also require that you install software before letting you write to disk. *—M. David Stone*

UPGRADE TIPS

Floppy Disk Drives

- External parallel-port drives are easy to install, but they tend to be slow. If speed is a priority, opt for internal IDE or SCSI.
- When comparing drive prices, consider the cost of all the disks you're likely to buy. A more expensive drive is sometimes cheaper in the long run.

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FAST CONNECTIONS

Before replacing your modem with a new 56K model, find out if your phone or cable company offers high-speed Internet and remote-access connections for businesses and homes. Cable modem, ADSL, and satellite services are rolling out rapidly and may be available sooner than you expect.

CABLE MODEMS

Cable modems provide fast Internet access over upgraded cable TV networks. Service is generally available only in residential areas, and only to about 25 percent of existing cable-wired homes; but that's growing rapidly. At the end of 1998, there were about 500,000 subscribers in North America, with nearly 60 percent subscribing to @Home. The other two major providers are MediaOne and RoadRunner.

A typical installation costs about $100, and the service runs from $35 to $50 per month. Downloads range from 384 Kbps to several million bps. The cable modem itself is an external box that you rent from your provider and attach to your PC via an Ethernet connection. Most providers include the Ethernet card and modem installation in their start-up charges.

The next generation of cable modems, slated to be available in the early summer of 1999, will likely be internal PCI cards or external USB units that conform to the upcoming DOCSIS standard. Since hardware will be standardized, you'll be able to purchase it from your local computer store. Prices are expected to be $150 to $300. Cable modem service almost always includes unlimited Internet access, and locating a service provider is simple: Just call your local cable operator and ask.

ADSL

Originally developed as a way to deliver video over phone lines, asymmetric digital subscriber line (ADSL) is entering the mainstream as a data communications service. ADSL delivers up to 8 Mbps downstream over ordinary copper phone lines. It's offered by an increasing number of local phone companies, but availability is spotty and pricing varies widely, with typical 1.5-Mbps service ranging from about $40 to over $100 per month. Some phone companies will act as your ISP for a DSL connection, but many just provide a DSL connection between you and your ISP or your office intranet—which means you'll need to factor in the ISP charge as well.

To use DSL, you'll need a DSL adapter, often (and incorrectly) called a *DSL modem.* Some providers give you the adapter as part of the service; others require you to purchase it from them. Expect to pay from $100 to $250 to get started. Most new adapters are internal ISA or PCI cards.

Until recently, there were at least six varieties of DSL, none compatible with the others. But a global standard—G.Lite—is now nearly complete, and virtually all DSL equipment makers are committed to supporting it. G.Lite provides up to 1.5 Mbps of downstream speed, and equipment for it should be relatively inexpensive.

1999 should be an interesting year for DSL development. Most major regional phone companies are planning service rollouts, and the first wave of G.Lite equipment should hit stores in the springtime—just in time for those rollouts.

The most difficult part of DSL may be locating a local provider. Check with your local phone company first; if it doesn't offer the service, it may be able to direct you to the DSL provider in your area.

SATELLITE

If cable or DSL isn't available in your area, don't despair. **DirecPC,** from Hughes Network Systems, offers 400-Kbps download speeds no matter where you live or work, using a small satellite dish pointed at the southern sky. Since satellite is a one-way medium, you'll still need the usual equipment for outbound data, including a phone line, conventional modem, and ISP account (through DirecPC or a third party).

There are several models of DirecPC systems, ranging from $300 to $700 (street) and available through computer stores and mail order. All offer the same data features, though some provide satellite TV in addition to Internet access. You can install the system yourself, or you can have it professionally installed for $150 or more, depending on the difficulty of your installation. Hughes is currently the only satellite ISP, so there's no competition to turn to if you're not happy with the service. Monthly fees range from a $30 basic residential package with 25 hours of usage (and the ISP account) to $130 for a business subscription with 200 hours of usage. (Hughes Network Systems Inc., Germantown, MD; 301-428-5500; *www.hns.com.*)

ISDN

Introduced in 1988, ISDN is an all-digital telephone service that operates over standard copper phone wires. It supplies two independent 64-Kbps channels that can be used for voice or data. ISDN is widely used for corporate remote access, but it

UPGRADE TIPS

Modems

- Before upgrading, make sure your phone line can support 56 Kbps. 3Com operates a free phone line test service; for details, see *www.3com.com/56k/need4_56k/linetest.html.*
- Most ISPs have updated their equipment to support the V.90 standard, but some still use x2 and K56flex. Check your ISP to see whether it's up to date.
- Some V.34 modems can't be upgraded to V.90, because their flash ROM is too small to hold bulky V.90 code. Several vendors have trade-up programs; check yours for details.
- Out of IRQs? Try a PCI rather than an ISA modem. PCI modems can share an IRQ line with other PCI peripherals, and they're easy to install.
- Out of slots and system resources? Try USB. External USB modems from MultiTech, Shark Multimedia, and 3Com don't need any PC resources, and the portable Shark Leopard Pocket USB 56K uses less battery power than a conventional PC Card modem (*www.sharkmm.com*).

Dawn Of The NT Workstation.

I/O for a blistering 12-fold increase in bandwidth over other PC workstations.** So whether you're into advanced 3D modeling, complex image processing, or video editing, you can now enjoy a level of throughput and graphics quality only Silicon Graphics can deliver. And the price? Less than you think. The Silicon Graphics 320™ workstation starts at just $3,395, less than some add-in graphics cards. Or choose the Silicon Graphics 540™ workstation** from only $5,995. Ready to handle up to four Intel® Pentium® II Xeon™ processors, it's the most scalable Windows NT workstation around. Either way, you can finally move from PC clones that crawl—to a machine that truly flies.

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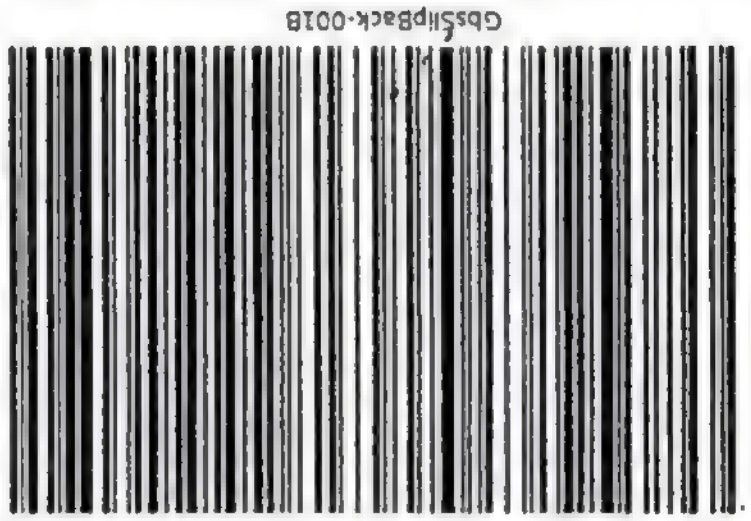
to 32 bit PCI. **For information on the availability of the Silicon Graphics 540 workstation please call 888 SGI-4289. Prices quoted are for U.S. only.



Back

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Inverted Back

1. Follow instructions on the other side

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GbsSlipSheet-001

Foldout slip-sheet

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2. Insert this sheet with
    1. Front side touching the free page
    2. Arrow pointing to the fold
3. Slice the folded edge
4. Close the page and slip-sheet

Inverted Foldout slip-sheet

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2. Insert this sheet with
    1. Front side touching the free page
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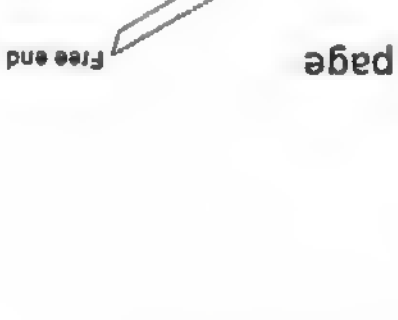
3. Slice the folded edge
4. Close the page and slip-sheet



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To get more information, find a local reseller, or to order, call

*Bandwidth based on graphics to main memory. †Requires additional software under Windows 4.0. **I/O bandwidth as

THE CLONING PERIOD.

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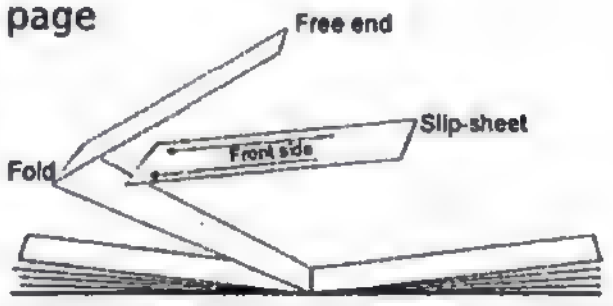

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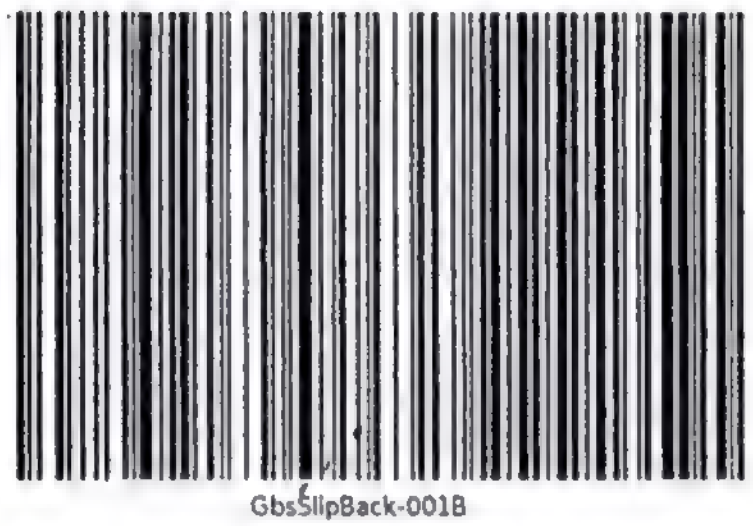

Back

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Osis

Silicon Graphics 320™ Visual Workstation, starting at $3,395

Base system includes:

- *Integrated Visual Computing (IVC) architecture with Cobalt™ graphics chipset*
- *Single (dual capable) Intel® Pentium® II processor 350MHz (up to 450MHz)*
- *128MB ECC SDRAM (expandable to 1GB)*
- *6GB Ultra ATA drive (expandable to 28GB of storage) or optional Ultra2 SCSI drive*
- *3 available PCI slots on two 64-bit PCI buses*
- *1.44MB floppy drive, 32X max. CD-ROM*
- *Integrated 10/100 Fast Ethernet*
- *IEEE-1394; parallel, serial, USB, video and audio ports*
- *Microsoft® Windows NT® 4.0*
- *3-year limited hardware warranty with 1-year onsite service*

Silicon Graphics 320, Modeling Station, $6,343

- *Single Intel® Pentium® II processor 400MHz*
- *256MB ECC SDRAM*
- *9GB Ultra2 SCSI drive*
- *100MB removable storage drive*
- *21" (19.8" viewable) monitor with Trinitron™ technology*

Silicon Graphics 320, Publishing Station, $8,283

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Silicon Graphics 540™ Visual Workstation,†† starting at $5,995

Base system includes:

- *Integrated Visual Computing (IVC) architecture with Cobalt™ graphics chipset*
- *Single (quad capable) Intel® Pentium® II Xeon™ processor 450MHz with 512K L2 cache*
- *128MB ECC SDRAM (expandable to 2GB)*
- *9GB Ultra2 SCSI drive (expandable to 54GB of storage)*
- *6 available PCI slots on two 64-bit PCI buses*
- *1.44MB floppy drive, 32X max. CD-ROM*
- *Integrated 10/100 Fast Ethernet*
- *IEEE-1394, parallel, serial, USB, video and audio ports*
- *Microsoft® Windows NT® 4.0*
- *3-year limited hardware warranty with 1-year onsite service*

Silicon Graphics 540, Modeling Station, $9,090

- *Single Intel® Pentium® II Xeon™ processor 450MHz with 512K L2 cache*
- *256MB ECC SDRAM*
- *9GB Ultra2 SCSI drive*
- *Silicon Graphics 1600SW 17.3" SuperWide digital flat panel monitor*

Silicon Graphics 540, A/V Station, $11,657

- *Single Intel® Pentium® II Xeon™ processor 450MHz with 512K L2 cache*
- *128MB ECC SDRAM*
- *Three 9GB Ultra2 SCSI high performance (10,000rpm) drives*
- *Dual stream M-JPEG compression/decompression engine*
- *21" (19.8" viewable) monitor with Trinitron technology*

Silicon Graphics 1600SW Flat Panel Monitor, $2,495**

- *17.3" 1600x1024 TFT SuperWide digital flat panel monitor with ColorLock technology*

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*Requires additional software (sold separately). **Cost of monitor when purchased with system. Prices quoted are for U.S. only. †† For more information on the 999 workstation, please call 888 SGI 4289.

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can also be used as an Internet connection. Most major ISPs support dial-up ISDN at no additional charge. From the user's point of view, ISDN works like a conventional modem connection: Your phone company provides the line and phone service, but you need to provide your own phone equipment and ISP account.

To connect a PC to an ISDN line, you need a terminal adapter, or TA—the ISDN equivalent of a modem. Eicon Technologies and 3Com Corp. each offer a broad range of internal and external TAs starting at around $180 (street).

If you want to connect your LAN to the Internet via ISDN, you'll need a router. ISDN routers provide dial-on-demand access, so they automatically establish connections to ISPs whenever LAN users start browser or e-mail programs. The inexpensive 3Com OfficeConnect ISDN ($350 street) provides excellent functionality for up to ten users; the Shiva AccessPort ISDN ($630 street) is better for larger LANs.

ISDN pricing varies widely from market to market, even within the same state. For example, in the area around Tampa, Florida, an ISDN line costs about $40 per month, with no usage charges. Move up a few hundred miles to Destin, Florida, and a line costs more than $80 per month plus usage charges. On balance, ISDN is a good deal for users who want instant connections but can't get ADSL or cable service and don't want to pay high satellite rates.

V.90 MODEMS

If you can't get any of these fast services or if they cost more than your budget allows, then it makes sense to upgrade to a V.90 modem. But before you do, make sure your phone line can get a modem connection faster than 33.3 Kbps. (For details see "Modem Upgrade Tips.")

V.90 modems are available in external and internal models. If you already own a 56K unit that conforms to the old x2 or K56flex, you can upgrade it to V.90 via a download from your vendor's Web site. The same is true for some 33.3K modems.

The least expensive V.90 modem we tested, the **ActionTec DeskLink Pro PCI Windows Modem** ($60 street), is an internal PCI model that offers good performance and a rich software bundle. The bundle includes Cheyenne's BitWare (telephony software with voice mail, caller ID, and fax broadcast capabilities). Installation is easy, but Windows 98 doesn't include a driver; you have to use the bundled installation disk. (ActionTec Electronics Inc., Sunnyvale, CA; 800-797-7001, 408-752-7700; *www.actiontec.com.*)

The **Boca TidalWave 56K External Speakerphone Modem** ($130 street) includes an external microphone and jumper cable to connect to the PC's sound input. Voice connections are clear, but the front-panel connectors create a mess of cables. Performance was good once we got past some problems connecting the modem to our 3Com backend equipment. (Boca Research Inc., Boca Raton, FL; 561-997-6227; *www. bocaresearch.com.*)

The **Compaq Microcom 415 56K External Modem with Speakerphone** ($150 street) comes with a nine-pin serial cable and connects to an external speaker or microphone via side-panel connectors. Compaq bundles lots of software, including Microsoft and Netscape browsers; Adobe Acrobat; Microsoft NetMeeting; PointCast; TeamWare's e-mail client, Embla; and the data/fax/voice communications center Trio, which uses caller ID to route incoming messages and faxes. Performance was excellent and installation easy. (Compaq Computer Corp., Houston; 800-888-0220; *www.compaq.com.*)

The internal **3Com U.S. Robotics Courier V.Everything Modem** ($240 street) is expensive, but it provides many business-oriented features, including remote management, automatic redial, and top-notch security. Its performance is outstanding, and it comes with a generous software bundle. 3Com also offers the lower-priced **3Com 56K Internal Faxmodem** ($130 street), which performs well and comes with excellent documentation. (3Com U.S. Robotics Corp., Santa Clara, CA; 800-342-5877; *www.3com.com.*)—*Les Freed*

UPGRADE TIPS

Fast Connections

- Don't ditch your modem until you determine that your local phone or cable company offers one of the high-speed connection services. Though they're being rolled out by more and more providers, coverage is far from universal. Be prepared to make several phone calls to determine availability.
- You'll pay a price for speed. The hardware costs $100 and up; services range in price from $35 to $130 per month, and often that doesn't include ISP fees of $20 to $40.
- If you have a fast connection to the Internet rather than modem dial-up, you can get unlimited AOL service for $9.95 a month, versus the typical $22.95.

PC MAGAZINE EDITORS' HOT LINKS

www.pcmag.com/hotlinks
From ISPs to hard disks, there's no more comprehensive personal computing coverage on the Web than PC Magazine's. *For the online version of this upgrades story and more, just go to the URL above.*

Ziff-Davis Benchmark Operation
www.zdbop.com
Here's where to get your own copies of the latest Ziff-Davis benchmark test suites to test the performance of your system's hardware components.

Official V.90 Modem Standard Site
www.v90.com
Go to this URL to learn about the newest 56K modem standard: how it works, who sells compatible products, and what the future holds.

ADSL Forum
www.adsl.com
A consortium of vendors dedicated to expanding ADSL as a communications interface. A good source for news and technical information.

USB: Universal Serial Bus
www.usb.org
The official Web site for USB information. It explains how USB works and includes an up-to-date database of vendors and products.

SCSI FAQ Page
www.ultranet.com/~gfield/gary/scsifaq.html
Gary Field has been keeping the most complete online FAQ page on the basics of SCSI technology for years.

System Optimization Information
www.sysopt.com
This Web site is devoted to hardware component information and to subjective evaluations of products, including motherboards and processors.

I/O CONNECTIONS

If you are considering upgrading, don't forget that interfaces are a vital part of a PC's infrastructure. A machine with USB or SCSI capability and an accelerated parallel port will expand your options and improve performance.

THE PROMISE OF USB

Make no mistake: You want USB (Universal Serial Bus) connectivity on your PC. This interface, standard on most every new PC sold in the past 18 months, lets you easily connect a range of hot-swappable devices: mice, joysticks, keyboards, scanners, storage drives, printers, and more (theoretically, as many as 127 at once). If your PC lacks built-in support, you can add an internal PCI card that gives your motherboard the necessary ports. Several makers offer these solutions; we tested the two-port **ADS USB Port** ($30 street) and the **Entrega 4 Port PCI** ($70).

Both hubs slip into PCI slots, and each worked equally well in our labs. As soon as we booted into Windows 98, the OS noted the new addition and added drivers. With that accomplished, adding a new device was as simple as plugging it into one of the ports on the hub. The ADS hub offers a manual with pictures and detailed instructions, but only a one-year warranty. Entrega offers a three-year warranty but only a single-sheet, text-only installation note.

If you already have USB ports but want more, an external hub is the easiest way to add them. We tested several four-port external models—the **ADS USB Hub** ($75 street), **Entrega 4 Port USB Hub** ($80), and **Peracom USB Quad Hub** ($95). For those serious about USB, seven-port models are available from these and other vendors.

Each of the external hubs came with an external power supply and status lights. Installation is quick and painless for all. Each of the three products worked right away; Windows 98 consistently noted the new device and added it to the Device Manger.

The Peracom USB Quad Hub has the most robust LEDs, with indicators for bus or local power, reset status, ports in use, and "up link"—which blinks under high data loads. ADS provides a power-on light and LEDs for each port. The Entrega 4 Port USB Hub has the smallest footprint and a three-year warranty. (ADS Technologies, Cerritos, CA; 800-888-5244, 562-926-1928; *www.adstech.com.* Entrega Technologies, Lake Forest, CA; 949-859-8866; *www.entrega.com.* Peracom Networks Inc., Cary, NC; 919-379-2700; *www.peracom.com.*)

Keep in mind that USB is not designed for speed and that it is an immature technology that still needs some kinks ironed out. Right now, only Windows 98 and Macintosh machines work reliably with it; support is limited under Windows 95 and nonexistent under Windows NT 4.0. The upcoming Windows 2000 (néeWindows NT 5.0) should handle USB well, however.

Be aware that when you're attaching new USB devices, bandwidth can be a constraining factor. USB shares its 12-Mbps pipeline with all the devices hooked to it, and it runs data over the computer's PCI bus, draining CPU resources. So if you try, say, to surf the Internet while playing music and printing—all with USB devices—performance will suffer. In our labs, when we were simultaneously connected to the Internet with a USB modem, playing music over a USB sound system, and writing to a USB Zip Drive, we noted dropouts in music playback while writing to disk and jerky video playback when downloading files.

Also be sure that any USB product you buy is fully compliant with Version 1.1 (it should say so on the box or in the documentation). The original USB had problems running simultaneous signals from a single port to both slow-speed devices (such as mice) and high-speed ones (such as scanners and storage drives). We saw this in our labs: Our test-bed PC locked up when trying to access a USB CD-ROM drive, because the USB port on the motherboard was hosting several other devices and wasn't Version 1.1–compliant.

Note that there's a separate power cable on many external hubs, which you need to plug into a power supply if you're running anything more power-intensive than a mouse or keyboard (such as a printer or scanner). Pay attention to detail when upgrading to any USB product, and read the manual; some products need to be installed onto the USB chain before you load the software, and others require the reverse. USB speaker systems that let you eliminate your sound card are among the trickiest to get running (for details see the sidebar "USB Audio: Ready Yet?" in "PC Sound: Better All Around," *PC Magazine,* February 9, 1999). Note that if you have an older CD-ROM drive that doesn't support digital audio extraction (DAE), you won't be able to play audio CDs via USB without going through the sound card (all USB speakers have analog inputs for such instances).

To compare USB with EIDE performance, we copied 95MB of data between two Iomega Zip Drives: one EIDE and one USB. The EIDE drive took just over 2 minutes, while the USB version lagged, at just over 3 minutes.

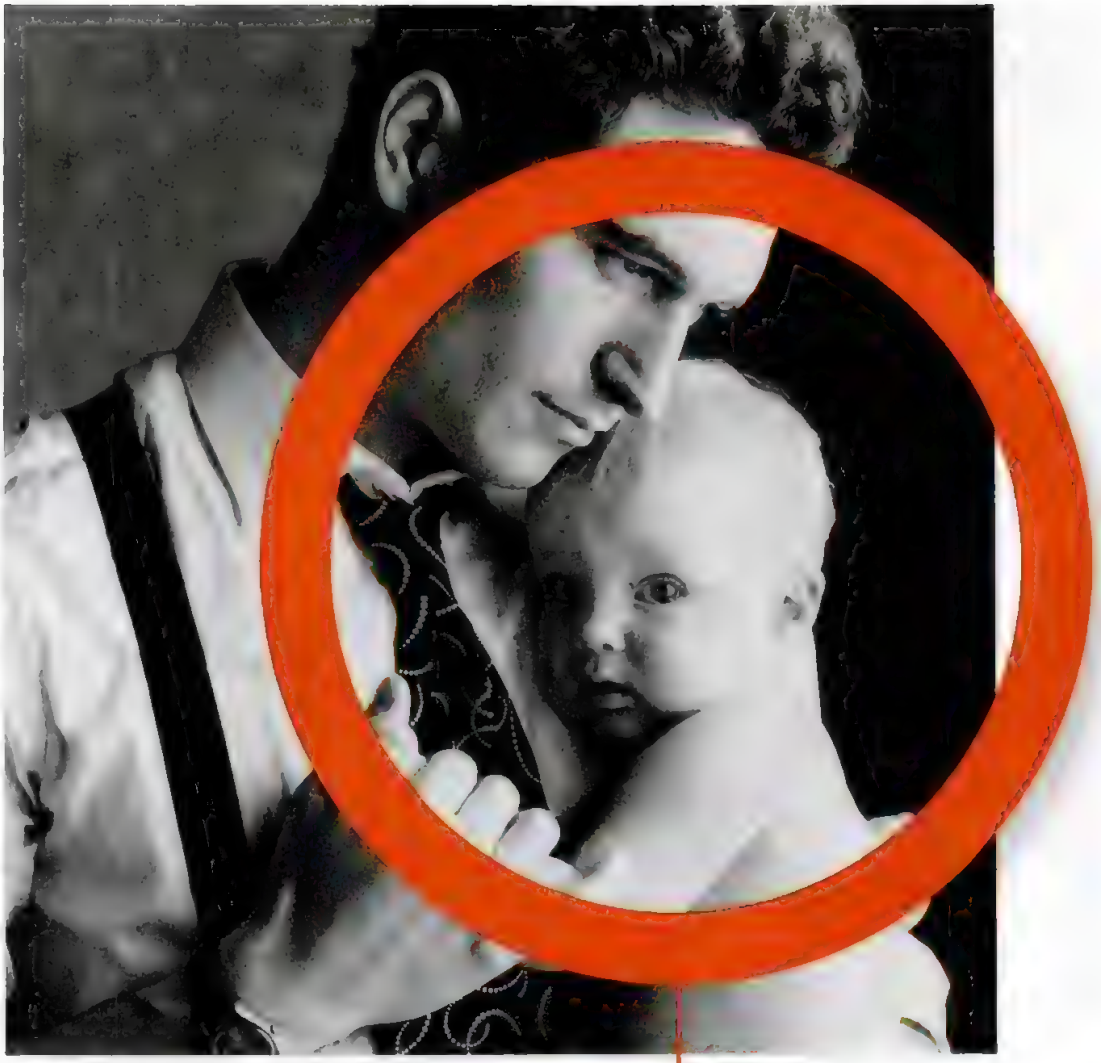
SCSI: THE EXPRESS BUS

For speed as well as flexibility, consider a SCSI port. SCSI offers the ability to daisy-chain up to 15 internal and external devices. More important, it delivers the speed that

UPGRADE TIPS

Interfaces

- Be sure any new USB hub complies with USB 1.1 or later. Older models can lose data if you mix low-demand devices such as mice with high-demand products such as disk drives.
- Install USB hardware and software in the order specified in the product's manual. Failure to follow directions may prevent the operating system from seeing a device or make the OS see it twice. Then you have to remove it and start over.
- Consider the total bandwidth and power requirements when adding new devices to a USB chain, and add them one at a time. You can slow a system to a functional crawl before reaching the maximum number of gadgets allowed.



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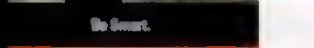

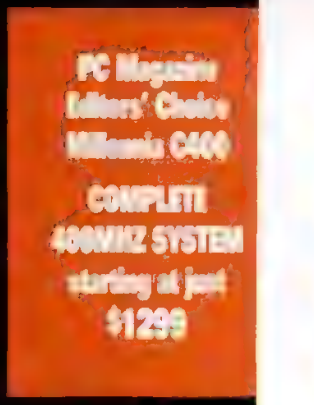

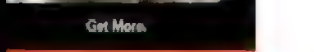

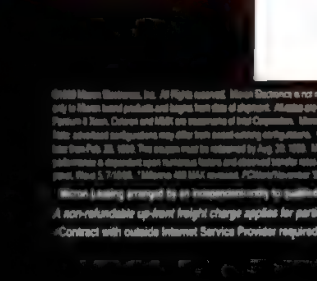

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- Diamond Viper V550 TnT 16MB graphics
- Microsoft® Windows® 98
- Microsoft Office 97 Small Business Edition
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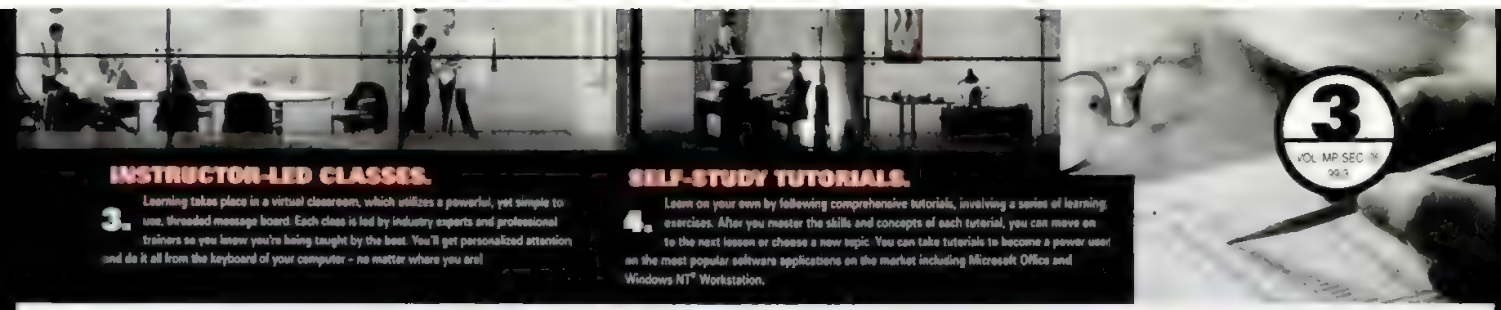

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Cache	128KB integrated L2 cache	512KB Internal L2 cache	512KB Internal L2 cache	512KB Internal L2 cache
RAM	64MB SDRAM	64MB 100MHz SDRAM	128MB 100MHz SDRAM	128MB 100MHz SDRAM
Hard Drive	8.4GB Ultra ATA hard drive*	8.4GB Ultra ATA hard drive*	8.4GB Ultra ATA hard drive*	13GB Ultra ATA hard drive*
Monitor	17" Micron 700Vx monitor (15.9" display)	17" Micron 700Vx monitor (15.9" display)	17" Micron 700Vx monitor (15.9" display)	17" Micron 700Vx monitor (15.9" display)
DVD/CD-ROM	40X max speed CD-ROM drive	40X max speed CD-ROM drive	6X DVD-ROM drive	6X DVD-ROM drive
Modem	3Com US Robotics V.90 Winmodem**	3Com US Robotics V.90 Winmodem**	3Com US Robotics V.90 Winmodem**	3Com US Robotics V.90 Winmodem**
Graphics	nVidia Riva 128, 8MB SGRAM 3D 2X AGP graphics	nVidia Riva 128, 8MB SGRAM 3D 2X AGP graphics	16MB Diamond Viper 550 Int'l 2X APG graphics	16MB Diamond Viper 550 Int'l 2X APG graphics
Sound System	PCI Yamaha wave Wavetable sound Advent AV570 speakers	PCI Yamaha wave Wavetable sound Advent AV570 speakers	PCI 3Com wave Wavetable sound Advent AV570 speakers	PCI 3Com wave Wavetable sound Advent AV570 speakers
Warranty	5-year/3-year Micron Power limited warranty	5-year/3-year Micron Power limited warranty	5-year/3-year Micron Power limited warranty	5-year/3-year Micron Power limited warranty
Additional Storage	3.5" floppy drive	3.5" floppy drive	3.5" floppy drive	3.5" floppy drive
Training	1-year free Training at Micron University	1-year free Training at Micron University	1-year free Training at Micron University	1-year free Training at Micron University
Factory Direct Price	$1,299 $46/mo. Business. Lease 36 mos.**	$1,699 $59/mo. Business. Lease 36 mos.**	$1,799 $63/mo. Business. Lease 36 mos.**	$1,999 $70/mo. Business. Lease 36 mos.**
Web Code:	50008	50003	40014	40010

PCWorld, "Best Buy," April '98

Replace your desktop with the Micron TransPort TREK²

Model Name	TREK²™ 266	TREK² 300	TREK² 333 New!	TREK² 366 New!
Processor	Intel Pentium II processor 266MHz	Intel Pentium II processor 300MHz	Intel Pentium II processor 333MHz	Intel Pentium II processor 366MHz
Cache	512KB L2 pipeline burst cache	512KB L2 pipeline burst cache	256KB L1 on die cache	256KB L1 on die cache
RAM	32MB SDRAM	32MB SDRAM	64MB SDRAM	64MB SDRAM
Hard Drive	3.2GB hard disk drive (removable)*	4GB hard disk drive (removable)*	4GB hard disk drive (removable)*	4GB hard disk drive (removable)*
Monitor	12.1" SVGA TFT display	12.1" SVGA TFT display	14.1" XGA TFT display	14.1" XGA TFT display
CD-ROM	24X CD-ROM (dedicated bay)	24X CD-ROM (dedicated bay)	24X CD-ROM drive - dedicated bay	24X CD-ROM drive - dedicated bay
Graphics	4MB AGP graphics accelerator	4MB AGP graphics accelerator	4MB AGP graphics accelerator	4MB AGP graphics accelerator
Sound System	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone
Warranty	5-year 1-year Micron limited warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty
Operating System	Microsoft® Windows® 98	Microsoft® Windows 98	Microsoft® Windows 98	Microsoft® Windows 98
Training	1-year free Training at Micron University	1-year free Training at Micron University	1-year free Training at Micron University	1-year free Training at Micron University
Factory Direct Price	$1,699 $59/mo. Business. Lease 36 mos.**	$1,999 $70/mo. Business. Lease 36 mos.**	$2,499 $88/mo. Business. Lease 36 mos.**	$2,699 $94/mo. Business. Lease 36 mos.**
Web Code:	20022	20023	20020	20021

366MHz

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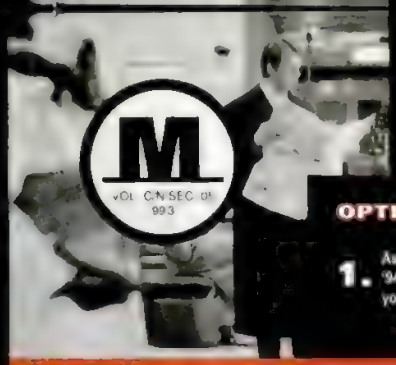
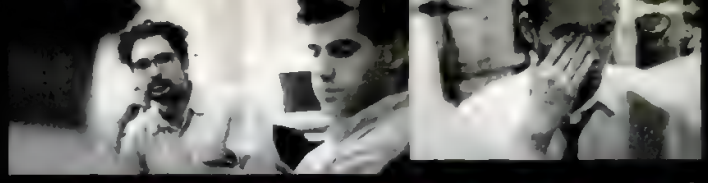


PUT THE POWER OF WINDOWS NT® TECHNOLOGY TO WORK FOR YOU.



OPTIMIZED FOR WINDOWS NT

1. As the first direct PC manufacturer to ship Windows NT back in '94, Micron's knowledge and experience can help you maximize your Windows NT network, now and into the future.

HIGH-PERFORMANCE, RELIABLE NETWORKING

2. The Micron ClientPro desktop and NetFRAME server utilize industry-standard technology and are powered by Intel's latest chip set technology, including the Intel Pentium II and Pentium II Xeon™ processors.

MICRON MAKES IT EASY TO HARNESS THE POWER OF MICROSOFT WINDOWS 2000

As the industry looks ahead to Microsoft Windows 2000 (built on NT technology), Micron offers a way to get ahead of the game today. Whether you're looking to upgrade to Windows NT® 4.0 Workstation or preparing for a company-wide shift to Windows 2000, our ClientPro® managed PCs and Micron™ NetFRAME® servers will be among the first to support the full potential of Microsoft Windows 2000. Network-ready right out of the box, built on industry standards, and packing the power of the Intel® Pentium® II processor 450MHz, the ClientPro puts more manageable power in your office. And if you're looking for a reliable and expandable server, it would be tough to beat Micron's NetFRAME servers running with the powerful new Intel Pentium II Xeon™ processor. Nothing maximizes a network today and tomorrow like Windows NT technology – and no one delivers it better than Micron. And as the first PC company to ship Microsoft Windows NT in 1994, it's no surprise that Micron's **AdvanceDeploy** program gives Micron users early access to Windows 2000.

"MICRON'S NETFRAME 3100 GIVES YOUR WEB CUSTOMERS WHAT THEY WANT BEFORE THEY CLICK AWAY."
— *PC Computing*, A-List, Best Web Server, Nov. '98

"MICRON'S DUAL-PROCESSOR... SERVER RUNS FULL SPEED AHEAD."
— *PC Computing*, A-List, Editors' Choice

So when you're ready to put the power of the ultimate business operating system into your office network, look to the experience and affordability of Micron ClientPro managed PCs and Micron NetFRAME servers. Call today for more information or to order direct from the factory or visit www.micronpc.com/pcmag.

Micron NetFRAME 6200

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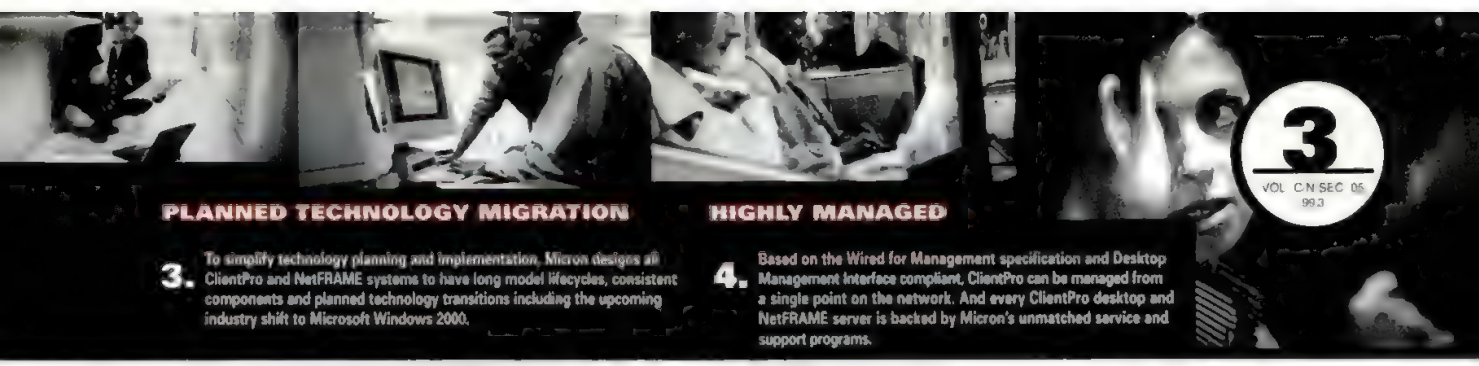
† Micron Leasing arranged by an independent entity to qualified commercial customers. Above lease payments based on 36 month, FMV terms and do not include taxes, fees or shipping charges. Leasing subject to credit approval and availability. Above lease terms subject to change without notice or obligation.



PLANNED TECHNOLOGY MIGRATION

3. To simplify technology planning and implementation, Micron designs all ClientPro and NetFRAME systems to have long model lifecycles, consistent components and planned technology transitions including the upcoming industry shift to Microsoft Windows 2000.

HIGHLY MANAGED

4. Based on the Wired for Management specification and Desktop Management Interface compliant, ClientPro can be managed from a single point on the network. And every ClientPro desktop and NetFRAME server is backed by Micron's unmatched service and support programs.

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pentium® II xeon™ PROCESSOR

ClientPro CS 450

The Highest Performing Managed PC†

Intel® Pentium® II processor 450MHz
512KB Internal L2 cache
128MB 100MHz SDRAM
8.4GB Ultra ATA hard drive*
17" Micron 700Vx (15.9" display)
32X max speed CD-ROM drive
8MB Real 3D Starfighter AGP graphics
64-voice PCI Wavetable sound
3Com 3C905 WOL 10/100 network card
5-year/3-year Micron Power™ limited warranty
1-year free† training at Micron U Online

Intel LANDesk® Client Manager
Microsoft® Windows NT® Workstation 4.0
Norton AntiVirus

SMART II hard drive monitoring
Chassis intrusion detection
Fan, temperature, and voltage problem reporting
Virus detection reporting
Remote Wake Up capability
MiniTower case
3.5" floppy drive
104-key enhanced keyboard
Microsoft IntelliMouse™

$2,049 $72/mo. Business Lease. 36 mos.

NetFRAME 3101

The Perfect Small Business Server

Intel Pentium II processor 400MHz
512KB Internal L2 ECC cache
128MB ECC 100MHz SDRAM
9GB UltraWide SCA hard drive*
32X max speed CD-ROM drive

5-year/3-year Micron Power limited warranty
Dedicated server technical support, 7x24
1-year next-business-day on-site service**
1-year next-business-day on-site service***

Intel LANDesk Server Manager
Emergency Management Port Console

Supports up to two Intel Pentium II processors 100MHz front-side bus and up to 1GB memory support
Integrated Ultra Wide SCSI-3 dual channel controller
Intel PRO/100+ Server Adapter
Integrated RAID upgrade support
5 expansion slots: 3 PCI, 1 ISA, 1 shared PCI/ISA
8 drive bays: 1 external 3.5", 2 external 5.25"
5 hot-swap redundant 1.0" hard drive bays

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NetFRAME 6200

High-Powered Server for Fast-Growing Businesses

Intel Pentium II Xeon™ processor 450MHz
512KB Integrated L2 ECC cache
128MB ECC EDO DRAM
9GB UltraWide LVDS SCA 1" hard drive*
32X SCSI CD-ROM drive

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Dedicated server technical support, 7x24
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1-year next-business-day on-site service***
MDS support (3 first-year incident resolutions)

Intel LANDesk Server Manager 6.0
Emergency Management Port Console
Microsoft Windows NT Server 4.0 (10-user license)

Supports up to four Intel Pentium Xeon processors
Options for 512KB, 1MB or 2MB L2 cache
4GB ECC EDO support (16 DIMM sockets)
Integrated Ultra-2 Wide LVDS dual channel & narrow SCSI controller
7 expansion slots: 6 PCI, 1 shared ISA/PCI
6 internal, hot-swappable hard drives bays
1 hot-swappable 400-watt power supply (upgradable to 3 w/redundancy)
3 external 5.25" media bays and floppy drive
Free-standing pedestal chassis standard (7u rack mount option available)

$6,999 $226/mo. Business Lease. 36 mos.*

NetFRAME 9200

The Mission-Critical Enterprise Server

Intel Pentium II Xeon processor 450MHz
512KB Internal L2 ECC cache
256MB ECC EDO DRAM
2 dedicated 4GB UltraWide LVDS redundant hot-swappable hard drives
32X max speed CD-ROM drive

5-year / 3-year Micron Power limited warranty
Dedicated server technical support, 7x24
1-year next-business-day on-site service**
1-year next-business-day on-site service***
MDS support (3 first-year incident resolutions)

Intel LANDesk Server Manager 6.0
Emergency Management Port Console
Microsoft Windows NT Server 4.0 (10-user license)

Supports up to four Intel Pentium Xeon processors
Options for 512KB, 1MB or 2MB L2 cache
8GB ECC EDO support (32 DIMM sockets)
Intel PRO/100+ Server Adapter w/Adaptive Load Balancing and Adapter Fault Tolerance software
Integrated Ultra-2 Wide LVDS dual channel controller
10 expansion slots: 4 hot-plug ready 64-bit PCI slots, five 32-bit PCI & 1 PCI/ISA slot shared
2 hot-swappable 750-watt 220-volt power supplies (upgradable to 3 w/redundancy)
7u rack mount chassis (cabinet and accessories sold separately)

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DataFRAME 450

The Highly Scalable Mass Storage System

Dual/Split SCSI bus disk sub-system w/8 drive bay capacity
1+1 (2 total) redundant hot-swappable power supplies (300 watts each)
9GB U2W LVDS SCA-2 hot swappable hard drive*
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Dedicated server technical support, 7x24
1-year next-business-day on-site service***

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Supports up to 8 SCA-2 hot swappable hard drives
Supports 1" or 1.6" hard drives heights
Maximum storage capacity: 144GB per enclosure
Ultra-2 Wide 80MBps transfer rate
Low Voltage Differential SCSI interface (12 meter cable length)
Optional deskside/pedestal version available

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power users crave: SCSI-based scanners, hard disks, and removable-storage drives generally outperform their EIDE or parallel counterparts. And for RAID, high-end scanners, and high-speed drives, SCSI is often the only connection option.

The heart of a SCSI subsystem is the host adapter, the expansion card that marries the other devices to the PC. Modern versions of such cards are plug-and-play PCI devices that take the work of managing devices off the PC's CPU, tying up only the PCI bus when data is moved off the SCSI chain. As the SCSI standard has matured, speeds have increased and connectors have been modified. Most host adapters now offer a variety of connectors to support old and new products.

To set up a SCSI chain, you must assign a unique ID number to each device, and the peripherals at the ends of the chain must be properly indicated as *terminations*. Termination used to be a major headache, but it's a lot easier now thanks to *self-terminating* functionality: automated drivers and built-in self-identifying features that come bundled with many drives. Many newer devices support SCAM, or SCSI Configured AutoMagically, which detects and sets SCSI ID numbers on the fly.

We compared host adapters from Adaptec and ATTO. Each company offers a variety of cards, with variations in the number of channels, types, and number of connections.

The **Adaptec 2940U2W** ($400 street) supports the latest Ultra2 Wide and Narrow SCSI-3 products and all legacy devices. It has two internal 68-pin connectors (one each for single-ended and wide differential drives), a 50-pin internal port, and a 68-pin external connector. The kit includes a variety of internal cables, one for every type of supported device. The card is fully plug-and-play–compatible under all major OSs, and it comes with Adaptec's software EZ-SCSI. The software includes tools for exploring the SCSI bus and checking on attached devices. For those on tighter budgets, the new **Adaptec 2930U2** ($315) is similar to the 2940U2W, but it lacks the connector and support for Ultra/Wide SCSI-3. (Adaptec Inc., Milpitas, CA; 800-442-7274, 408-945-8600; *www.adaptec.com.*)

The compact, half-size **ATTO Express-PCI Ultra-2 SCSI** ($545 list) has fewer ports than the Adaptec product, bundling only a single 68-pin wide port and a 68-pin external port. It supports both Mac and Windows platforms. We installed the card without problems in our labs, but it lacks the extras that ship with its competitor. (ATTO Technology Inc., Amherst, NY; 716-691-1999; *www.attotech.com.*)

To push the limits of SCSI connectivity, we hooked up a variety of devices to each card—two scanners, a tape drive, two hard disks, a CD-ROM drive, and a CD-R drive—with similar results. In the early days of SCSI-2, it would have taken over an hour to set jumpers, configure the adapter, and play with the settings for all this—and another hour or so to play around to get everything running. Now, with SCSI-3, we could load the OS in less than 15 minutes, and everything worked the first time.

To test speed, we compared backup times for transferring 1GB of assorted graphics and data files to an IDE tape drive (the Seagate TapeStor Travan) and a SCSI version of the same drive connected to the Adptec SCSI interface, using Seagate's software BackUp Exec (800-327-2232, 407-531-7501; *www.seagate.com*). The IDE transfer took more than 11 minutes; SCSI completed the backup in just under 2 minutes. SCSI showed an advantage over USB as well. The HP ScanJet 6250 color flatbed scanner, which has SCSI and USB connectivity, scanned an 8- by 10-inch color image in 30 seconds over a USB connection and in only 19 seconds using the SCSI interface.

Desktop Interfaces

	TYPICAL USES	BURST DATA-TRANSFER RATE	OUTLOOK
Internal Peripherals			
ISA	Sound cards, modems	2–8.33 MBps	Phased out by late 1999
PCI	Graphics cards, SCSI adapters, recent sound cards	133 MBps (new version, 266 MBps)	Standard add-in peripheral bus for the foreseeable future
AGP	Graphics cards	528 MBps	Standard in all Intel Pentium II and Celeron PCs; coexists with PCI
Storage and External Peripherals			
ATA/IDE	Hard disks, removable-media drives, CD and DVD drives	3.3–33.3 MBps	Standard internal storage bus for the foreseeable future
SCSI	Hard disks, removable-media drives, CD and DVD drives, scanners	5–80 MBps	Standard high-end peripheral bus for the foreseeable future
USB	Pointing devices, scanners, cameras, speakers, printers, monitors	12 Mbps	May eventually replace serial and parallel ports
IEEE 1394	Digital video cameras, high-speed storage drives	400 Mbps	Will become common in high-throughput devices by the end of 1999

BEEFING UP PARALLEL PORTS

In addition to SCSI and USB, the parallel and serial ports on your PC are possible items for that upgrade shopping list. You can find PCI cards that give you extra parallel or serial ports while still occupying only one IRQ; and for a Zip Drive, digital camera downloads, a scanner, or other high-volume operations or devices, you can add a high-speed port.

Lava Computer makes the **Lava Parallel-PCI** ($50 street) parallel-port upgrade card. We installed one on our test-bed and attached a parallel-port version of the Iomega Zip Drive. Windows 98 detected the card without problems, but we had to modify the resource settings so the drive would work properly. We also had to run an Iomega utility to get the full speed advantage from the Lava card. With that accomplished, we quickly made back our investment of time. We copied a variety of graphics and data files, large and small, using both the parallel port on the motherboard and the new Lava. Times varied, but always in favor of the new addition. In all cases it took no more than half the time of the standard port; often it took closer to one-third the time. If you use your printer port for more than just paper output, the Lava card should be on your short list. (Lava Computer MFG Inc., Rexdale, Ontario, Canada; 800-241-5282, 416-674-5942; *www.lavalink.com.*)
—*James Karney*

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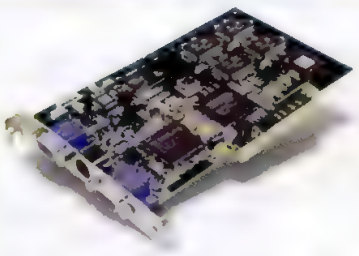
Thinking about upgrading your monitor? Here's something they didn't teach in school — going from your current 17-incher to a pricey 21-inch is expensive, and it doesn't really give you that much extra room. This is what the smart fish do — get a second 17-inch monitor and use an Appian Graphics card to unite your two screens in a single display. Even figuring the cost of the card and the second monitor, you'll save yourself money. And you'll have a much [illegible] multiple-monitor cards, and our products are optimized for Windows 98. To find out more, swim on over to **www.appiangraphics.com/fish** or call toll-free 1-877-7APPIAN

Designed for Microsoft Windows 98



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Any questions? Check the IRS Web site at **www.irs.ustreas.gov** or your tax preparation software.

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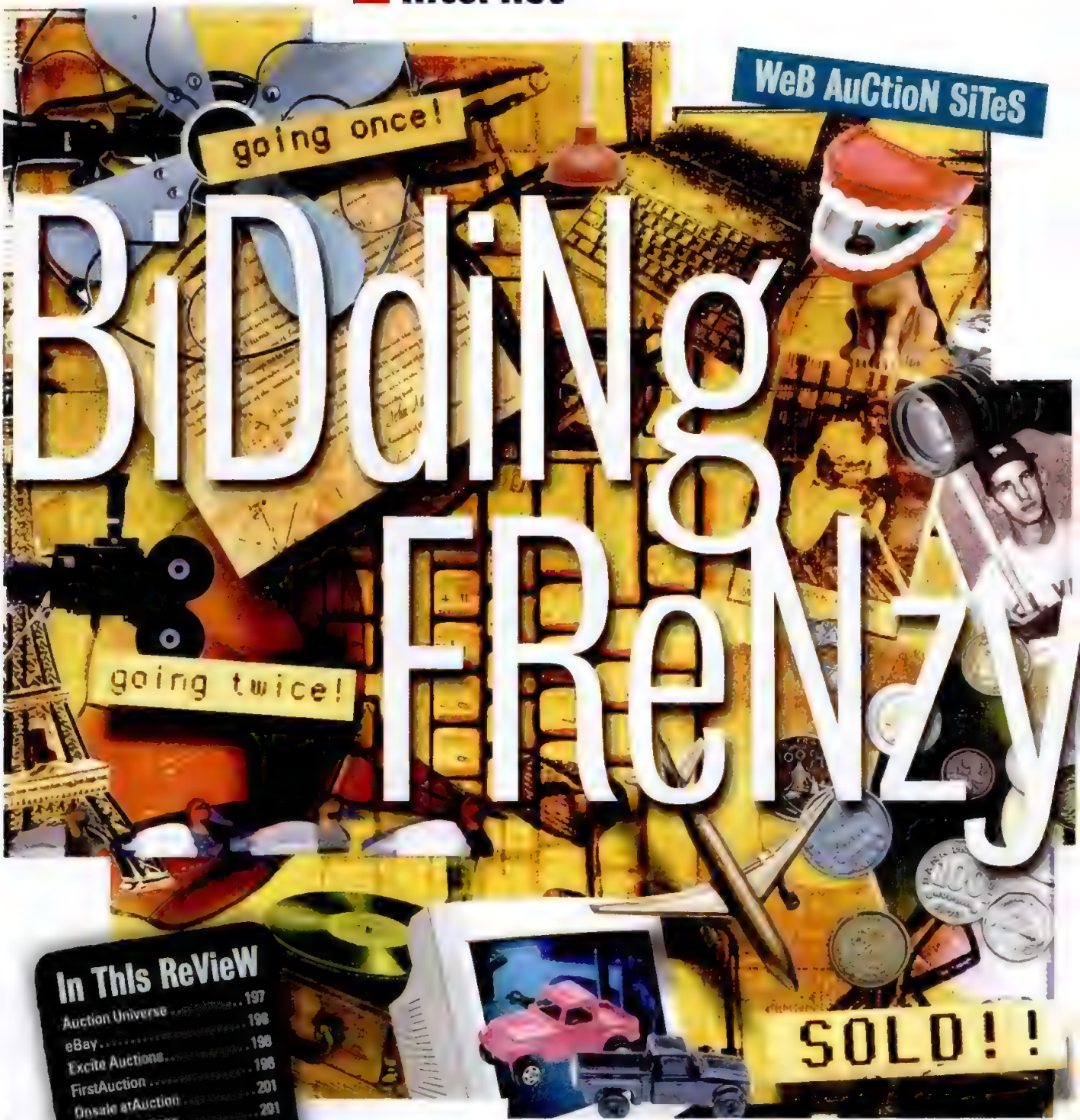

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Auction Universe 197
eBay 198
Excite Auctions 198
FirstAuction 201
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How We Tested 197

ILLUSTRATION BY TERRY MIURA. INSET BY TIMOTHY COOK

By Larry Seltzer

WHERE WOULD YOU GO to buy a 450-MHz Pentium II PC? Probably a computer store. Where would you go to get the chance of buying a 450-MHz Pentium II PC for a dollar? A Web auction site.

Auctions take Web shopping to a new level by adding in the X factor of competition. This creates a habit-forming Web activity, whether you're seeking bargains on computer equipment or indulging your passion for collecting antique cameras.

The Best Auction Site For...

We looked at more than 100 auction sites to spotlight the best deals on the Web for enthusiasts of every stripe. By Alan Cohen

Tips and Information

The Auction Guide
www.auction-guide.com

Chock-full of handy tips and explanations of auctions and auction terminology, this is a great site for online auction basics. Check out the Money List, updated monthly, which notes those sites where closing prices are consistently below market value.

Meta-Auction Searching

Bidder's Edge
www.bidderedge.com

A promising concept in need of some tweaking: Bidder's Edge follows eight of the most popular Web auctions, including four of the six we review here (sorry, Excite and Yahoo! Auctions fans).

Using the site's search engine, find items, add them to your watch list, and track bids from a single page. This is terrific in theory, but in practice it's a bit unreliable. For example, our search on "computer" returned just one item from eBay: a set of Beanie Babies!

Computer Products

Onsale atAuction
www.onsale.com/atauction.htm

It sounds like a computer maker's dream: Use your PC to buy more PCs. Onsale bests its numerous computer auction competitors with an impressive selection of both new and refurbished desktops, notebooks, monitors,

This is the delicious synergy of the Internet and capitalism—frictionless commerce—where buyers and sellers meet in the digital marketplace to arrange for a fair price without an intermediary. We review the auction sites that offer the widest variety of items for sale and were getting the most traffic at press time. We also consider the best auction sites for those who want to find specialized goods such as golf clubs and various collectibles.

Auction houses on the Web exist in two forms: person-to-person auction sites and house auction sites. *House auction sites,* such as FirstAuction and Onsale, sell merchandise directly to bidders, in a relatively traditional commerce relationship. The house sites auction off a company's surplus stock, often at bargain prices.

Person-to-person sites, such as eBay, operate more like flea markets. They bring individual buyers and sellers together and facilitate bidding but don't have any role in completing the transactions or verifying the authenticity of the goods. Sellers describe their products and set bidding constraints, such as the minimum (reserve) price they'll accept for an item. You are likely to find anything and everything you can think of (and some things you can't believe!). Almost all of the items are used, many are sparsely described, and generally you have no idea who the sellers are. This frictionless commerce is a good thing?

Well, yes. Even though the environment might seem a bit shady, most Web auctions are safe places to shop. House auctions, of course, are just like dealing with any other online merchant: You have accountability through established and published policies.

But person-to-person auctions have safeguards, too: Each site we tested has a feedback system that lets you review other people's experiences with a particular seller, and they all support escrow services—third parties that act as intermediaries in the transactions. For a commission (and possibly a small annual fee), an escrow service will accept payment from the buyer and hold it until the product is received in proper condition.

Once you try an online auction, your biggest concern is not going to be the sellers but yourself. The last few minutes of an auction can get hectic, and in all the excitement, we have seen people bid prices up above retail.

EdiToRs' CHoiCe

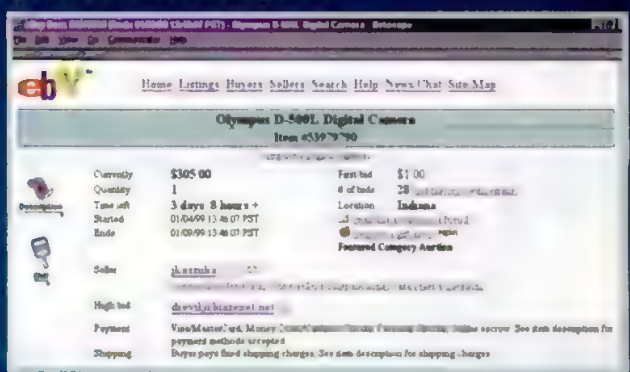
- Person-to-person auctions: eBay
- House auctions: Shop around

PC MAGAZINE EDITORS' CHOICE

The thrill of competition, the prospect of a great deal, and every product you could ever think of— these are what make Web auctions simply irresistible. The site that best delivers on their promise is eBay, our Editors' Choice.

No other Web auction site can match eBay when it comes to variety, the number of products up for auction at any given time, and most important, the number of people buying and selling. eBay makes it easy to find the products that interest you with its capable search engine. There is also an excellent feedback system, so you can learn a seller's reputation before you start bidding.

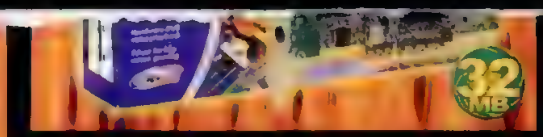
If you prefer to buy new products at auction or would feel more comfortable buying from a company rather than an individual, you'll find scores of house auctions on the Web. No one site stands out for general excellence, but check our sidebar "The Best Auction Site For..."—giving the best sites for buying specific items such as computers.



Our Contributors: LARRY SELTZER is a frequent contributor to *PC Magazine*. ALAN COHEN is a freelance writer. JAY MUNRO was the project leader, and DAVID LIDSKY was the associate editor in charge of this story.

ILLUSTRATIONS BY TIMOTHY COOK

GRAPHICS BY
rage



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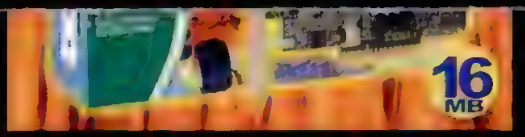
- 32MB of memory to handle massive graphics textures and deliver outstanding performance
- Advanced 3D architecture with Single Pass Multi-Texturing
- Full 3D acceleration in all modes, all color depths, and all resolutions up to 1920x1200
- Full OpenGL, DirectX 6.0 and Direct 3D acceleration
- Hardware DVD for full-frame, full-screen DVD playback
- TV-Out for a big-screen gaming experience



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The Graphics and DVD Powerhouse

ATI brings striking graphics performance and DVD video to home, small office and home-based business PCs. It's the best all-round graphics upgrade you can buy.

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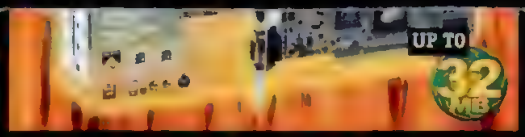
- Hardware DVD for full-frame, full-screen DVD playback to save the added expense and hassle of installing a separate MPEG-2 decoder
- Full OpenGL, DirectX and Direct 3D acceleration
- Advanced 3D architecture with Single Pass Multi-Texturing
- Full 3D acceleration in all modes, all color depths, and all resolutions up to 1600x1200



All-IN-WONDER 128

The Ultimate Multimedia Upgrade

It's the RAGE 128-based addition to the number one all-in-one TV, graphics and video upgrade. In fact, there's practically nothing you can't do – from running the very latest games and applications, to watching TV and capturing and replaying video.

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- TV-Out for a big-screen gaming experience
- Hardware DVD for full-frame, full-screen DVD playback

For complete product specifications, industry reviews and where-to-buy, check out www.atitech.com.

GRAPHICS BY ATI rage 128

The New Breed of Speed.

ATI

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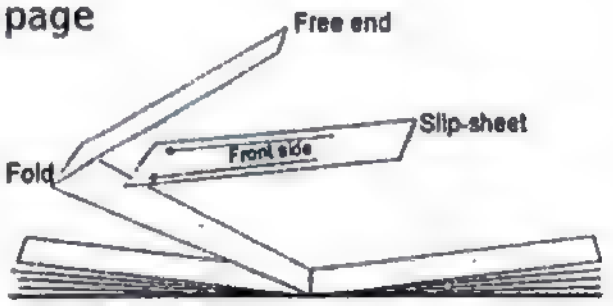

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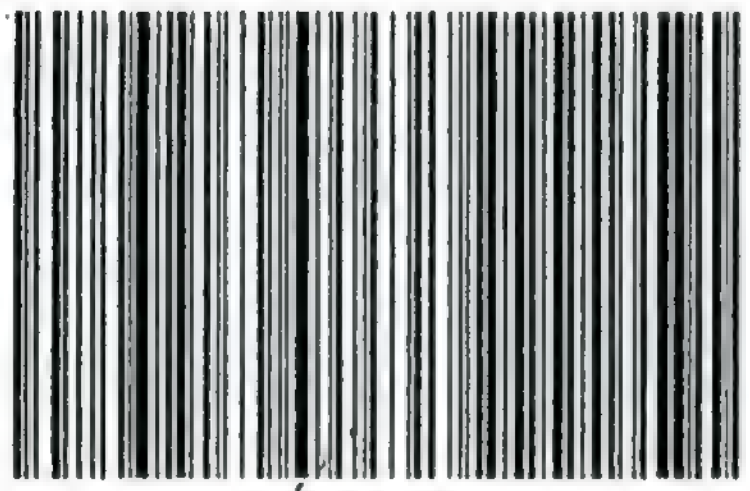

Back

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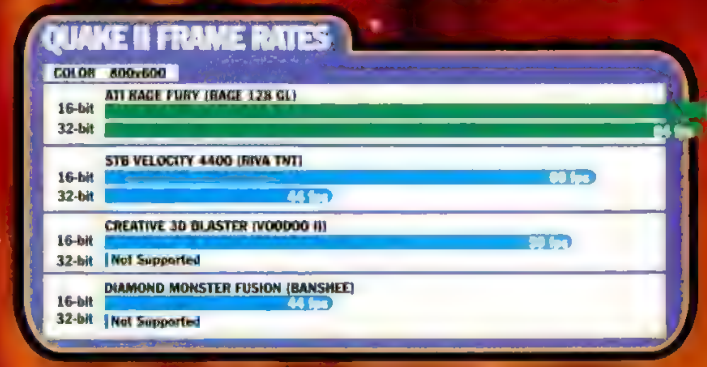


True 128-Bit Graphics • 32-Bit Color • Up To 32MB • SuperScalar Rendering • Hardware DVD

128
ATI RAGE 128 Is Born.
Graphics Scream.

WeB AuCtioN SiteS: HOW WE TESTED

To truly way to test Web auction sites properly is to get out your virtual bidding paddle and participate. We spent two months immersing ourselves in the process and buying at three sites.

Registering at each site, we took note of what was required of us to become a member. We paid particular attention to each site's policy regarding buying and selling.

Since there should be more buyers than sellers, we devoted most of our time to being a buyer. We created a wish list of dozens of products, ranging from a 200-MHz Pentium II PC to autographed Mark McGwire memorabilia. Then, we went on to try finding these products at each site over the course of our testing, using both the search capabilities and each site's directory structure.

We monitored, participated in, and bought products from auctions at each of the six reviewed sites. We tracked opening bids, the rate and flow of bidding activity, and various ways to judge the traffic at each site and the potential for bargains. We sought out auctions in as many varied categories as each site offered, looking for any particular specialty.

The bidding experience at each site was a primary concern. We evaluated the flexibility of the bidding software, proxy bidding, the reliability of notifications, and the amount of detail about each product, as well as the payment and shipping options. We reviewed each site's design, its interface, integration of features, and the ease with which you can navigate the site.

Furthermore, we considered the safeguards available to buyers in knowing who the seller is. We looked for detailed seller ratings and comment pages, the ability to retract bids, escrow services, and the level of personal information members must publish.

To evaluate the best sites for sellers, we thoroughly analyzed every site's bidding traffic, the fee structure for listings and prominent placement, and the required user information disclosure.

RATINGS

POWER	Auction Universe	EDITORS' CHOICE eBay	Excite Auctions	FirstAuction	Onsale atAuction	Yahoo! Auctions
Bidding experience	Good	Good	Fair	Good	Good	Excellent
Product selection	Fair	Excellent	Fair	Good	Good	Fair
Product search	Excellent	Excellent	Poor	N/A	Fair	Fair
Product directory	Excellent	Good	Fair	Good	Good	Excellent
Selling experience	Excellent	Excellent	Fair	N/A	N/A	Good
EASE						
Bidding experience	Good	Excellent	Good	Excellent	Good	Excellent
Product search	Good	Excellent	Poor	N/A	Fair	Good
Product directory	Good	Good	Fair	Fair	Good	Excellent
Selling experience	Excellent	Excellent	Excellent	N/A	N/A	Excellent

N/A—Not applicable. The site does not have this feature.

Add Web auctions to your list of places to look for just about anything. Not only will you get a shot at a great deal, but you may also have fun.

Auction Universe

www.auctionuniverse.com

All reviews by Larry Seltzer

With the best thought-out directory structure of any auction site and a very capable search engine, Auction Universe impresses as a site with what it takes to be the best. But a good auction site needs lots of buyers and sellers, and as you explore what's up for auction, you'll quickly discover that there's not a whole lot for sale here. Unless you want to be a pioneer, you'll probably want to go to eBay, because so much more is available for purchase there. And if you're a seller, you'll find more potential buyers.

As at eBay and other person-to-person sites, you'll find thousands of Beanie Babies for sale, but while browsing other categories such as photo equipment or computers, you'll often come up empty. Under Photo Equipment, the site had only 8 cameras and no lenses. When we checked at eBay, we found more than 2,500 cameras and more than 1,300 lenses.

Further compounding the problem, some sellers post unrelated items to a large number of categories in order to increase exposure. We experienced more of this problem at Auction Universe than at other sites. For example, we discovered a "Fix Your Credit" program for sale in the PC/56K Modem category.

When you do locate something to bid on, the site makes good use of small icons in its listings to help you quickly determine the characteristics of individual auctions, such as a red R for reserve auctions, before you dig deeper.

printers, scanners, CPUs, and more. The selection is vast, and name brands abound. A nice touch: Users can cancel bids within 15 minutes of making them.

Household Items

uBid

www.ubid.com

Buying a dishwasher may still require a trip to Sears, but toasters, irons, and coffeemakers are regularly turning up for bids online. uBid's selection could be more comprehensive, and a search engine would help, but the items are brand-name and often brand-new. Shipping charges and warranty information are noted; good deals can be had.

Travel Deals

Travel Bids

www.travelbids.com

Pick a travel agent the way the government picks contractors: Let the lowest bidder win. Travel Bids offers a reverse auction, where it is the seller who bids. Travelers make a reservation with an airline and list the trip on the site (for a $5 fee). Agents who want to issue the ticket then bid discounts off the fare. The idea is simple: Since the legwork has already been done, the agents will kick back part of their commission.

Collectible Cars

LiveBid

www.livebid.com

Up until now, obtaining a car interactively meant guessing the right vowel on "Wheel of Fortune." LiveBid provides a mechanism so those who cannot attend a live car auction can bid from their computers in real time. A licensed auctioneer conducts the auctions.

Toy Collectibles

eBay
www.ebay.com

Old toys never die; they just find their way onto eBay. From the Atari 2600 and

Talking G.I. Joe to every Beanie Baby ever to walk the Earth, someone here is sure to be selling the stuff your mom once threw out. Beware, eBay's staggering array of offerings means there's a lot of junk among the treasures. And overzealous collectors can drive prices beyond market value.

Sports Collectibles

Auction Universe
www.auctionuniverse.com

Thanks to the anonymity of the Web, one can buy Bill Buckner memorabilia and still live safely in Boston. Baseball cards rule, but there are many other categories, including some obscure ones such as Cricket Memorabilia. You can also access this area through *The Sporting News'* Web site (*www.sportingnews.com*), and that helps drive traffic here. The bidding can often be fierce.

Golf Clubs

Golf Club Exchange.com
www.golfclubexchange.com

You won't find plaid pants or white shoes here. This site, which acts as middleman between buyers and sellers, covers only one of the three golfing essentials: clubs. The selection is vast and would be overwhelming if it weren't for a powerful search engine that makes finding specific woods, irons, and putters easy. Winning bidders are charged immediately, but payment stays in escrow until the clubs ship and a 48-hour inspection period has passed.

eBay
www.ebay.com

The most famous and popular of the auction sites, eBay deserves its renown because of the astonishing number of items for sale, the large community that's been attracted to it, and a very well-implemented set of features.

eBay's product offerings are very diverse, with more than 1,000 categories, and we had no trouble finding almost anything we looked for—from CPUs to Big Bertha golf clubs. We also found that eBay frequently will have more than one of an item that other sites don't have at all.

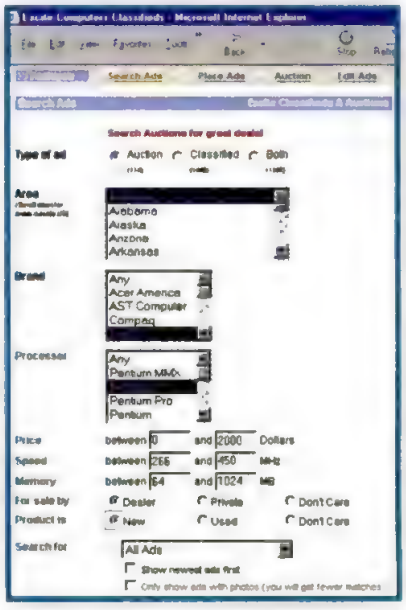
Person-to-person auctions can be pretty woolly sometimes, with illegal, highly suspect, and adult items up for bid, and eBay has more than its share of these products. The site does provide some built-in safeguards, which are better than those of its competitors. It's the only site that won't let you register with a free e-mail account, such as Hotmail, unless you're willing to back that up with a credit card. Around the time you read this, eBay will also have a verified user program. Pay a $5 fee and submit detailed information (name, phone number, social security number, and more) to eBay and you'll be identified as a verified user. All participants are traceable and therefore legally accountable.

The seller information page, a staple of all the person-to-person sites, is handled best at eBay. You get an at-a-glance look at the total number of positive and negative comments a given seller has received. It's also organized by date, so you can gauge recent performance as well. And eBay is the only site that links you to comments about the people making comments, which is a nifty extra.

Since an auction's last few minutes are often when the action heats up, visit eBay's Going, Going, Gone page—a unique feature where you'll locate all the auctions that are about to close. This is where you can find the real bargains.

Excite Auctions
www.excite.com/collectibles

When you boil down person-to-person auctions, they are really just classified ads with a little sport added. That might explain why Excite has merged its auction site within Classifieds2000, the excellent site it owns. The auctions here look and feel much like the standard ads you find in Classifieds2000. The advantage is that buyers will find a bevy of items both up for bid and just plain for sale in the same place. But an annoying consequence is that Classifieds2000's interface is not the most auction-friendly. Excite Auctions also falls short where most other sites—except eBay —do: a real lack of bidders.



Excite Auctions' search disappoints.

The service's interface is very disappointing, with no global search engine for auctions and no real directory. Go two levels down (Computers, then PC Notebooks, for example) and you'll find yourself at a search page. Some of the sections don't offer a keyword search, so you have to use the cumbersome interface.

We did, however, find some unique features here. Though every site in the roundup effectively notifies you when you're outbid and when you win, Excite Auctions is the only one with Cool Notify, which lets you search for what you want and then receive e-mail whenever new items meeting your criteria are posted.

FirstAuction
www.firstauction.com

You like participating in Web auctions, but you're not as big on buying goods from someone named chippy2726, no matter how positive his seller ratings are. You want to check out a house auction site like FirstAuction. Along with Onsale, FirstAuction differs from the other sites in this story in that its merchandise more closely resembles what you'd find in a department store (although some is refurbished), and buyers deal directly with the auction site. FirstAuction is worth a look for deals on general merchandise, but Onsale has a much better selection of computer equipment.

FirstAuction's selection differs greatly from what you'll find at other sites in this roundup. Its six top-level category headings are Home & Leisure, Health & Beauty, Jewelry, Lingerie, Consumer Electronics, and Computer Products. FirstAuction had

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fewer products up for auction than any of the other sites, although we did see its volume increase during testing. Because the site traffics in more general goods, most items tend to be new—more so than Onsale's.

The most interesting feature of FirstAuction is its Flash-Auctions, which are half-hour auctions of 9 products held 14 times a day. Given the very short term, you can get some real bargains. The items in FlashAuction vary widely from hour to hour, reflecting its variety of offerings.

Onsale atAuction

www.onsale.com/ atauction.htm

Before you buy any computer-related products, you need to stop into Onsale first. It has a great selection and offers the opportunity to get an unsurpassed deal. FirstAuction, the other house auction in our roundup, has a more diverse selection of merchandise but no particular specialty.

Onsale's auctions feature more name-brand products than others.

Onsale's computer offerings are impressive, rivaling even sprawling eBay's. Here, the big advantage is that products are all new or factory-refurbished, and most come with manufacturers' warranties—things you're unlikely to find at eBay. At Onsale, we noted that unlike the person-to-person sites, few computer-equipment auctions attract no bids at all.

Express Auctions—1-hour speed auctions in which all products start at $1—are an especially good way to find bargains. They run hourly from noon to 11:00 P.M. eastern time and are similar to FlashAuctions. Both sites provide ample product information and a fast-paced bidding experience. But Onsale annoyingly lets you see only the current high bidder, whereas FirstAuction gives you the whole bidding history to feel the auction's flow.

A standard feature among auction sites is the ability to set up a proxy bidder—a utility that lets you enter the maximum price you're willing to pay for an item and then bids for you up to that price. Onsale has one called BidMaker, but this is the only site that doesn't activate it for you automatically.

Onsale's noncomputer auctions are less exciting. As with FirstAuction, some start out with high minimum-bid requirements and lapse after attracting few bids, if any.

Yahoo! Auctions

auctions.yahoo.com

If you're familiar with Yahoo!, then you'll feel at home at its auction site, Yahoo! Auctions. The basic auction categories have the same appearance as Yahoo!'s search categories. And they are well populated with merchandise. As with Auction Universe, though, the problem here is a lack of bidding action on what's for sale, so if you're selling something, don't expect the traffic found on eBay. But Yahoo! Auctions is still probably a site to watch, given the high volume of traffic that Yahoo! can attract.

Yahoo! Auctions, powered by Onsale, is similar in many ways to the auction site of its portal rival Excite—including the problem of too few buyers. Like Excite, it's free to sellers, which explains the large number of them. And both sites have search function problems.

Yahoo! Auctions' search problems can be critical, because some of the categories have hundreds of items to dig through. On our tests, trying to search within a specific category resulted in searching the entire auction database. This made some items difficult to find. For example, a search for "Canon" in the Hardware/ Printers category found lots of Canon Bubble Jet printers, but mixed in were Canon cameras.

Once you find an item you want at Yahoo!, the process is excellent. Yahoo! does a good job of linking the site into its larger community, with numerous links to areas such as chat and message boards. (*PC Magazine*'s majority holder, Softbank, is a shareholder of Yahoo!) PC

Stamps

StampAuctions

www.stampauctions.com

The perfect place for a stamp collector with an inheritance, this busy site features a wealth of stamps in dozens of categories—a good thing for a stamp collector who wants to fill out a thin collection. Bidders can view sellers' feedback ratings, which is a welcome touch. But novice philatelists, be warned: These descriptions are loaded with stamp-specific terminology, and there's no glossary.

Coins

Coin Universe

www.coin-universe.com

Until someone invents an online slot machine, this site will be your best bet for parlaying change into riches via cyberspace. Comprising dealer and consignment auctions supplemented by price guides, the latest articles, and breaking news, this site is aptly named indeed. The auction search engine may not be the most intuitive, and there's no seller's feedback, but all the extra information, message boards, and a chat room make up for these failings.

Wine Collecting

Winebid.com

www.winebid.com

Why run up the Bimmer's mileage crisscrossing the Napa Valley when you can buy that fine chardonnay on the Web? This site is easy to pore over, with each wine described in detail by type, vintage, bottle size, and condition. An estimated price range, determined by Winebid's experts, is given as well—great for the would-be bidder. Auctions are held monthly.

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Infoworld, Snap! Server Simplifies Small-Network Storage Chores, May 25, 1998

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Nation's Business, A Network Storage Product that's true to its name, June 25, 1998

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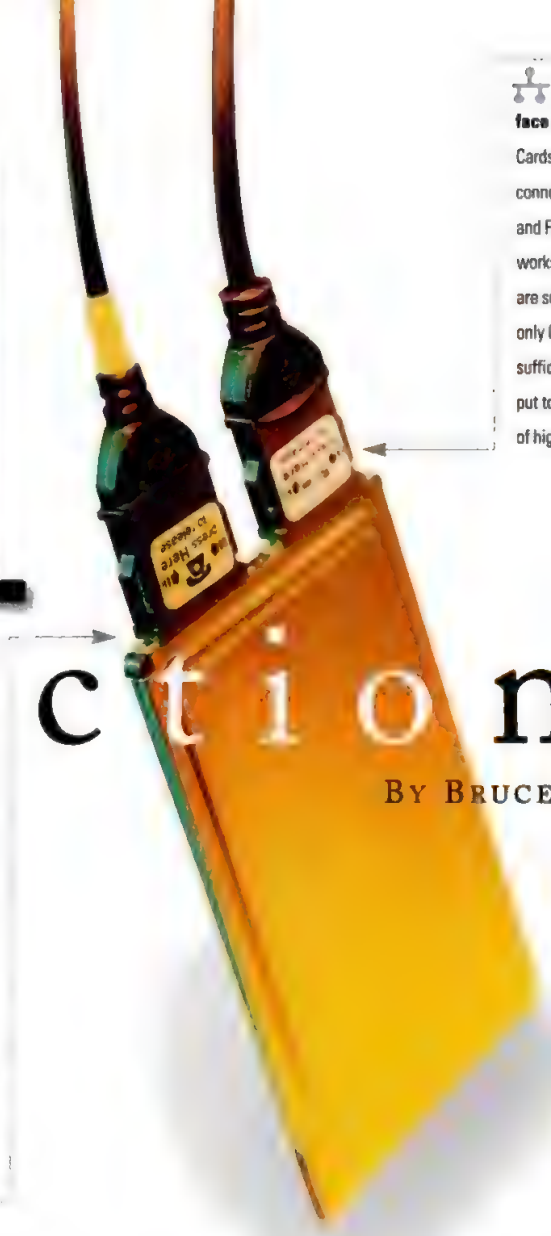
Cards for all connections



Network interface cards: All of the PC Cards we test here can connect to both Ethernet and Fast Ethernet networks. Though 16-bit cards are suitable for most tasks, only CardBus cards offer sufficient network throughput to tap the true potential of high-speed networking.

By Bruce Brown

These slot-saving LAN-modem cards keep you in constant contact with the office or the Internet.

Modems: With support for the latest 56K standards (V.90 and K56flex), these cards deliver the fastest dial-up connections available for accessing your corporate LAN via a remote-access server, browsing the Web, or checking your e-mail.

As notebook PCs get thinner and lighter, peripherals are also doing their part to cut down on the clutter you need to carry around. Combination PC Cards are a case in point. These credit card–size devices merge the functions of a modem and a network interface card, or *NIC*, so whether you're at the office or on the road, you need only one device to stay connected to your corporate LAN or browse the Web.

For this story, we tested seven combination PC Cards that support the latest communications standards including 56K modems as well as both Ethernet (10-Mbps) and Fast Ethernet (100-Mbps) networks. These cards, ranging in street price from $280 to $370, offer several advantages

PHOTOGRAPHY BY JEFFREY KREIN

Compaq Microcom 550 56K Modem + 10/100 Ethernet PC Card 204
IBM 10/100 EtherJet CardBus Adapter with 56K Modem 206
Intel PRO/100 Mobile Adapter LAN + Modem56/32bit CardBus 208
Ositech Jack of Spades CardBus 10/100 + 56K Modem with DPI PC Card 208
SysGear MultiGear MG56-10/100TX 214
3Com Megahertz 10/100 LAN + 56K Modem PC Card 217
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over single-function cards. First, they let you keep a slot open for other devices. The exception is the Xircom RealPort CardBus Ethernet 10/100 + Modem 56, which is a Type III card. Second, these cards offer a single, quick setup routine that installs everything you need for both modem and network connections. Finally, depending on the design, these cards can reduce the number of cables and dongles that you need to carry.

The cards we reviewed fall into two major categories: Three of them (from Compaq, SysGear, and 3Com) rely on the original 16-bit PC Card interface; the other four (from IBM, Intel, Ositech, and Xircom) employ the newer, 32-bit interface known as CardBus. The key difference is that CardBus supports speeds of up to 33 MHz and has a 32-bit data path, so cards can transfer data much more quickly. Although this has virtually no effect on modem and 10-Mbps Ethernet communications, it has a dramatic impact on high-speed networking.

On our Ethernet tests, the 16-bit PC Cards and CardBus cards had average throughput scores of about 5.8 Mbps and 6.8 Mbps, respectively. But when we switched to Fast Ethernet, the CardBus cards notched an average throughput of 42.8 Mbps, while 16-bit cards topped out at 8.3 Mbps. In other words, CardBus cards are about five times as fast as 16-bit cards on typical network tasks. On our modem tests, however, the CardBus issue is moot. In fact, two of the 16-bit cards, from SysGear and 3Com, were, at about 30 Kbps, approximately 50 percent faster than the rest of the field.

One drawback to CardBus that we discovered during testing is that it automatically assigns the modem to the COM5 port. For applications that support Microsoft's Telephony API (TAPI), this poses no problem. But there are some non-TAPI applications—AOL 4.0, for example—that don't support COM ports greater than COM4. Although you can change these settings in the Windows Registry (we did), most users will find this solution unsuitable. Three of the CardBus vendors (IBM, Intel, and Xircom) provide utilities to help reassign the COM port, if necessary. Regardless, we'd like to see better documentation of this problem and an easier fix.

In addition to CardBus support, the physical design of the card and its cables are a key differentiator. The most innovative design belongs to the Xircom card, which makes good use of its added girth by incorporating standard jacks for RJ-11 and twisted pair RJ-45 cables directly into the card. If you forget your cables, all you need to do is find a standard phone line or network cable and you're back in business. Most other cards use proprietary dongles or cables.

If your company already has a Fast Ethernet network or is planning to upgrade, or you often perform network-intensive chores such as replicating entire e-mail files or backing up your system, by all means opt for the latest and greatest. If you spend a lot of time on the road, however, you should pay more attention to modem performance. No matter how you work, you'll find a card here that suits your style.

editors' choice

The 3Com card is a performance leader.

The versatile Ositech card works on PBXs.

- 16-bit: 3Com Megahertz 10/100 LAN + 56K Modem PC Card
- CardBus: Ositech Jack of Spades CardBus 10/100 + 56K Modem with DPI PC Card

PC MAGAZINE EDITORS' CHOICE

Top-notch performance, reliability, a space-saving and convenient design—all these factors go into a good communications solution. Two cards, the Ositech Jack of Spades CardBus 10/100 + 56K Modem with DPI PC Card and the 3Com Megahertz 10/100 LAN + 56K Modem PC Card, possess these qualities, earning our Editors' Choice designation.

The Ositech is a Type II card with a CardBus interface. It uses proprietary cables that plug directly into the edge of the card and works on both analog and PBX (digital) phone lines. The Ositech produced the fastest throughput on our Ethernet tests (7.7 Mbps). The 16-bit 3Com card was the fastest of the 16-bit cards in both Ethernet (6.4 Mbps) and Fast Ethernet (9.7 Mbps) throughput tests, and it had the highest overall modem throughput (30.6 Kbps).

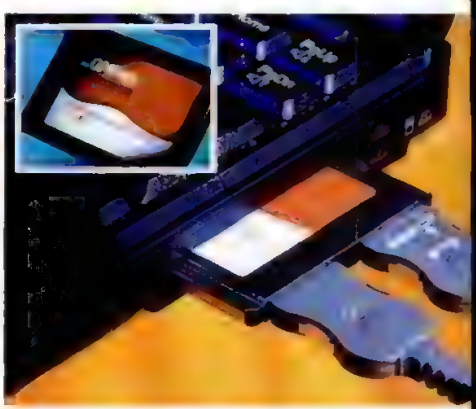
A third product, the Xircom RealPort CardBus Ethernet 10/100 + Modem 56, deserves honorable mention for a groundbreaking design that integrates standard ports directly into the edge of a Type III card.

All reviews by Bruce Brown

Compaq Microcom 550 56K Modem + 10/100 Ethernet PC Card

Type II 16-bit card; $300 street. Houston; 800-345-1518; www.compaq.com.

● The Compaq Microcom 550 56K Modem + 10/100 Ethernet PC Card produced lackluster scores on our tests and has few distinguishing features. This midpriced, 16-bit combo card is popular with new Compaq notebook customers seeking a one-stop



The Compaq Microcom combo card is a mid-price card with average performance.

Our Contributors: BRUCE BROWN is a contributing editor of *PC Magazine*. RUSS IWANCHUK was the project leader, and JOHN MORRIS was the associate editor.

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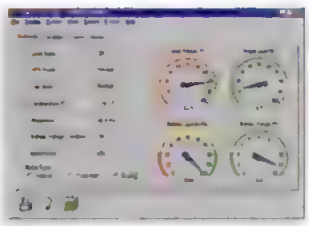

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PERFORMANCE TESTS

Combination PC Cards

For this story, we tested 16-bit and CardBus PC Cards. Of the 16-bit cards, the 3Com Megahertz was the leader. For CardBus cards, only 1.1 Mbps separated the fastest from the slowest on our Fast Ethernet test.

As the name implies, a combination card is really two devices crammed into a single card, in the sense that it has separate chips for network and modem connections. We tested both these functions. Our Network Tests, conducted at both 10-Mbps Ethernet (10Base-T) and 100-Mbps Fast Ethernet (100Base-TX) speeds, measure the relative throughput that each card sustains when used over a corporate LAN. The Modem Tests reflect both the performance of the modem (the average throughput measured in Kbps) and the card's ability to cope with adverse phone-line conditions. Finally, to ensure compatibility, we tested each card under Microsoft Windows 95, 98, and NT 4.0.

NETWORK TESTS

Not surprisingly, our tests confirmed that the only area in which the CardBus interface offers a significant performance advantage is Fast Ethernet (100 Mbps). The 16-bit bus, based on the ISA bus, has a maximum data transfer rate of 16 MBps. CardBus, derived from PCI, can operate at speeds of up to 33 MHz and has a 32-bit data path, resulting in a maximum data-transfer rate of 132 MBps (yes, we mean mega*bytes* per second).

Whether you need a CardBus card depends on the way you typically utilize connections. For standard e-mail and Web browsing, for instance, the greater throughput capability of CardBus NICs will rarely come into play. But if you perform more network-throughput–intensive jobs, such as backing up your hard disk to a server, replicating your e-mail file, or copying large batches of files, you'll see a real difference.

Although the theoretical limit of Fast Ethernet is 100 Mbps, our throughput results were in the 40s (for CardBus cards). There are a couple of reasons for this. First, we tested these cards as the vast majority of them will be used: as client NICs. In this role, the laptop PC driving the NIC can't request data fast enough to saturate the NIC's bandwidth potential. Second, the maximum throughput that any NIC can sustain is never as high as the theoretical maximum wire speed of the network because of the overhead exacted by the NIC driver and the operating system when processing the data.

MODEM TESTS

Our modem throughput test results were more clear-cut, with two obvious winners: the 3Com (30.6 Kbps) and the SysGear (30.2 Kbps). The next-best performer, the Ositech, scored about 30 percent lower than the SysGear. Note that our tests introduced line impairments; you are likely to see higher throughput with 56K modems under better conditions. 3Com is the only vendor here that uses its own chip set; hence this card's showing came as no surprise: The 3Com V.90 modems exhibited the best performance in our recent roundup ("Your Last Modem?", December 15, 1998). The ability to negotiate a strong connection under adverse line conditions also comes into play. Under these circumstances, some modems have to retrain to a lower connection rate or resend packets, resulting in a lower average throughput. On our tests, we saw situations in which the IBM EtherJet, Intel PRO/100, and Xircom RealPort could not establish connections under particular line impairments, making the cards less attractive buys for the mobile user, who may encounter a variety of line conditions.

COMPATIBILITY TESTS

We tested each card with Windows 95 OSR2, Windows 98, and Windows NT Workstation. None of the cards had any trouble under Windows 95 or 98: The OS automatically detected the card, prompted us for the location of drivers, and properly installed the NIC and modem components. Windows NT Workstation, however, is quite another story. First, Windows NT doesn't support Plug and Play, so the OS detects the card while booting up, but not on insertion. Furthermore, the lack of Plug and Play means that sorting out IRQs

shopping solution, but there is no compelling reason for others to choose it over the better-performing cards reviewed here.

Boasting two clearly marked dongles, this Compaq card uses a single Type II card slot and includes a user manual, as well as full documentation on CD. Installation took us only 5 minutes. Unfortunately, neither the setup process nor the documentation makes reference to the bundled communications software Trio DataFAX 5.3. By contrast, the 3Com Megahertz 10/100 LAN + 56K Modem PC Card has an integrated install that includes all the third-party communications software.

After setup, the Compaq card worked without a problem. It supported simultaneous network and modem activity, as well as network speed switching. Lights on the dongles show activity, and different-color LEDs indicate network speed. The Compaq card delivered average performance on both our Fast Ethernet (7.7 Mbps) and our Ethernet (6.0 Mbps) tests. But with an average throughput of only 18.5 Kbps, it was the slowest of the seven products on the modem tests.

Aside from its mediocre performance, the Compaq Microcom 550 56K Modem + 10/100 Ethernet PC Card has no major flaws, but neither does it offer anything to separate it from the pack. Though it costs a little more, the 3Com card is a better choice if you're looking for a 16-bit solution.

IBM 10/100 EtherJet CardBus Adapter with 56K Modem

Type II CardBus card; $280 street. Armonk, NY; 800-426-3333, 914-765-1900; www.ibm.com; 500 at www.pcmag.com/infolink.

●The IBM CardBus 10/100 EtherJet CardBus Adapter with 56K Modem is an able performer on Fast Ethernet networks, but it's less notable for its Ethernet and modem performance. The IBM card offers few frills, and its chief selling point is its $280 street price, which makes it a bargain among CardBus cards.

We took about 5 minutes to install the IBM card, which comes with a one-page quick-install card backed by a user manu-

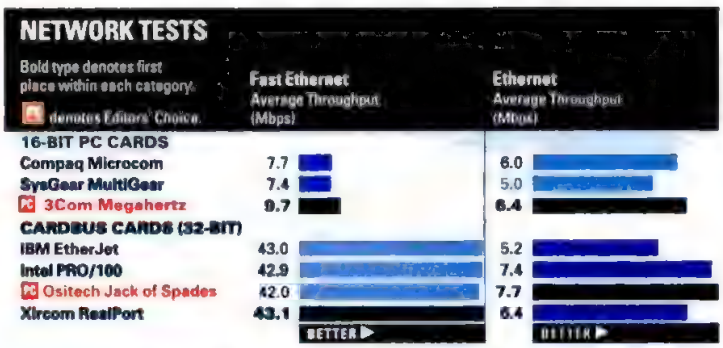
and I/O addresses is a hassle. We had to shuffle resources for every card except the Ositech and the 3Com. Our advice: If you're running Windows NT, check with the PC Card vendor to make sure your laptop is on its compatibility list.

How We Tested

To test NIC performance, we used ZD NetBench 5.01's NIC throughput test. We performed **Network Tests** on an IBM ThinkPad 600E with a Pentium II/300 processor, 64MB of RAM, and CardBus slots, running Windows 98. Our test network included an Intel Express 10/100 Stackable Hub connected (using TCP/IP) to a Dell OptiPlex GX1 with a Pentium II/400 processor and 256MB of RAM, running Windows NT Server 4, SP 4. The ThinkPad used each card to make repeated 1K requests for a file on the server for 120 seconds. We used a 100MB test file to ensure that the client could not cache it, which would artificially inflate test results.

To test modem performance and robustness under impaired phone line conditions, we used ZD Labs' **Modem Tests**. We installed each product in a Gateway Solo 2500 with a Pentium II/300 processor and 64MB of RAM, running Windows 98. Each card was connected via Windows Dial-Up Networking to an Ascend Max 4048 remote-access server (RAS) with Rockwell digital modems. To simulate a phone network, we dialed over a Telephone Analysis System (TAS) 240 local-loop emulator and a TAS Series II central-site simulator. To measure the throughput under each line condition, we downloaded a compressed file to the Gateway notebook from an FTP server. The number we report for each modem is the average throughput (Kbps) for the 56 real-world line conditions.

To ensure compatibility, we performed a series of tasks with each card using three different operating systems, and several popular makes and models of notebook PCs. Our Windows 95 OSR2 test laptop was a Toshiba Tecra 8000 with a Pentium II/300 processor and 64MB of RAM; for Windows 98 we used a Gateway 9100 XL; and for Windows NT Workstation, SP 3, we used the IBM ThinkPad. After installing each card, we created simultaneous connections with a network-based server and a RAS. We also tested for 10/100 auto-sensing capability by switching the speed of our 10/100 hub while the client continuously pinged another device on the network.—*Analysis written by Russ Iwanchuk*



▲ The four CardBus cards, from IBM, Intel, Ositech, and Xircom, all performed similarly on our 100-Mbps Fast Ethernet tests: The Ositech's low score (42.0 Mbps) was less than 3 percent below the leading score produced by the Xircom (43.1 Mbps). We saw more variation in Ethernet performance of the CardBus cards. Here the Ositech (at 7.7 Mbps) and Intel (at 7.4 Mbps) performed best. Among the 16-bit cards, the 3Com stood out by achieving 9.7 Mbps over Fast Ethernet. The next-best performer, the Compaq, came in 21 percent behind. The 3Com also got the highest Ethernet score in the 16-bit group, outperforming even the IBM CardBus-based NIC.

▲ Two PC Cards, the 3Com and the SysGear, pulled away from the pack on modem tests with throughput scores of 30.6 and 30.2 Kbps, respectively. The next-best performer, the Ositech, trailed the SysGear by about 30 percent. Three cards, the IBM, the Intel, and the Xircom, failed to establish connections under some adverse line conditions on our tests.

al. Like the other CardBus cards we tested, the IBM card configures the modem as COM5. And like Xircom, IBM includes with the card a Comsel.exe utility for reassigning COM ports—Intel offers one for download—but you'll be hard-pressed to find it, because neither the tool nor the topic is mentioned in the user manual. No extra software is bundled with the IBM card.

Based on the Xircom chip set, the IBM 10/100 EtherJet CardBus Adapter with 56K Modem employs a two-dongle design with LEDs on the dongles for activity and network speed. We had no problems with simultaneous network and modem operation, but automatic network-speed switching didn't work as smoothly.

The IBM card delivered a strong performance on the Fast Ethernet tests (43.0 Mbps). But at just 5.2 Mbps, it lagged behind the other CardBus cards on Ethernet tests. In fact, two of the 16-bit cards (the Compaq and the 3Com cards) handily outperformed the IBM card on Ethernet tests. Furthermore, its modem performance (19.7 Kbps) was the second-slowest in our roundup.

Despite its strong Fast Ethernet performance, the IBM 10/100 EtherJet CardBus Adapter with 56K Modem lacks the all-around performance and the features found in the other products reviewed here.

The IBM 10/100 EtherJet CardBus Adapter with 56K Modem is a no-frills PC Card.

PC MAGAZINE EDITORS' HOT LINKS

www.pcmag.com/hotlinks

The Web is a great place to find products, services, and resources on portable computing and networking.

➤ **AT&T Telework Guide**
www.att.com/ehs/telecom.html
AT&T ought to know a little about telecommuting. More than 50 percent of the company's US–based managers (36,000 employees) telecommute. This site is designed to assist other companies in establishing telework policies.

➤ **MobilePlanet Inc.**
www.mobileplanet.com
Dedicated to the road warriors, this reseller's site is packed with any and every portable-computing product for the mobile professional. MobilePlanet also offers services including consulting, system configuration, paging and e-mail, and technical support.

➤ **1-800-Batteries**
www.800batteries.com
Sure, this site has batteries for every devices you can think of, from laptops to cell phones to camcorders. But it offers loads of other gear for the gadget-happy traveler.

➤ **Port Inc.**
www.port.com
One of the leading destinations for globe-trotting computer users, Port is recognized for its array of carrying cases. But the company manufactures and sells a wide range of products for portable computing as well.

➤ **PC Magazine's Road Warrior Guide**
www.zdnet.com/pcmag/special/roadwarrior/_open.htm
The Road Warrior Guide provides checklists and tips for preparing to travel, as well as important contact information for various service providers and notebook manufacturers.

➤ **TeleAdapt**
www.teleadaptusa.com/
No matter where your travels take you, TeleAdapt has the equipment to keep you connected. TeleAdapt offers a comprehensive range of products including 40 telephone plug adapters for foreign phone systems.

Intel PRO/100 Mobile Adapter LAN + Modem56/32bit CardBus

Type II CardBus card; $280 street. Santa Clara, CA; 800-628-8686, 408-765-8080; www.intel.com; 501 at www.pcmag.com/infolink.

● With the Intel PRO/100 Mobile Adapter LAN + Modem56/32bit CardBus, what you see is what you get. Like the other cards based on the Xircom modem chip set, the Intel card delivered only average modem performance, and it offers no extras. Nevertheless, the Intel card has few weaknesses, so it's a reasonable, low-priced solution.

During testing, we took about 5 minutes to install the Intel card. All the installation software and drivers are stored on a single CD, and once you begin, the installation requires almost no intervention. The printed documentation is sparse, but Intel augments it with an illustrated electronic manual. Aside from a few utilities, no additional software is included.

The Intel card has a standard design, and it produced mixed performance results.

Once installed, the card worked correctly on both 10-Mbps and 100-Mbps LANs while supporting simultaneous modem and network connections. Like the other CardBus devices, the Intel modem selects COM5 by default. A downloadable utility lets you reset the COM port. Although it bears the same name (Comsel.exe) as the one bundled with the Xircom card, these utilities are not interchangeable.

Like the cards from Compaq and IBM, the Intel card offers two dongles. Also like these two cards, the Intel card yielded a relatively low modem throughput score (20.7 Kbps). It fared much better on network tests, with solid throughput for both Fast Ethernet (42.9 Mbps) and Ethernet (7.4 Mbps) networks.

A thoroughly conventional CardBus combo card, the Intel PRO/100 Mobile Adapter LAN + Modem56/32bit CardBus is a safe choice. But it won't attract any second glances from fellow road warriors.

Ositech Jack of Spades CardBus 10/100 + 56K Modem with DPI PC Card

Type II CardBus card; $370 street. Guelph, Ontario, Canada; 888-674-8324, 519-836-8063; www.ositech.com; 502 at www.pcmag.com/infolink.

PC MAGAZINE EDITORS' CHOICE

One of the most interesting cards in this roundup, the Ositech Jack of Spades CardBus 10/100 + 56K Modem with DPI PC Card has an ace in the hole: its support for both analog and digital (PBX) and phone lines. Add to this the card's solid performance and bundled connection cables and you'll find that Ositech has dealt a winning hand.

The Ositech card uses a single Type II card slot. The separate, proprietary 6-foot modem and Category 5 network cables plug directly into the edge of the card. Although all the cards we tested offer digital-line protection, the Ositech's Digital Phone Interface (DPI) is the only one that allows you to make connections over digital lines via the phone's handset. A special dialog box pops up to assist in making the connection.

Our installation went smoothly. Aside from a quick-start guide, Ositech offers no printed documentation, but the CD-based manual is sufficient. Also included on the CD is CommLite, a communications package. Like the other CardBus modems, the Ositech installed by default as COM5. Unfortunately, Ositech does not provide a

The Ositech Jack of Spades is a good performer boasting some unique features.

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a big impact. Even the
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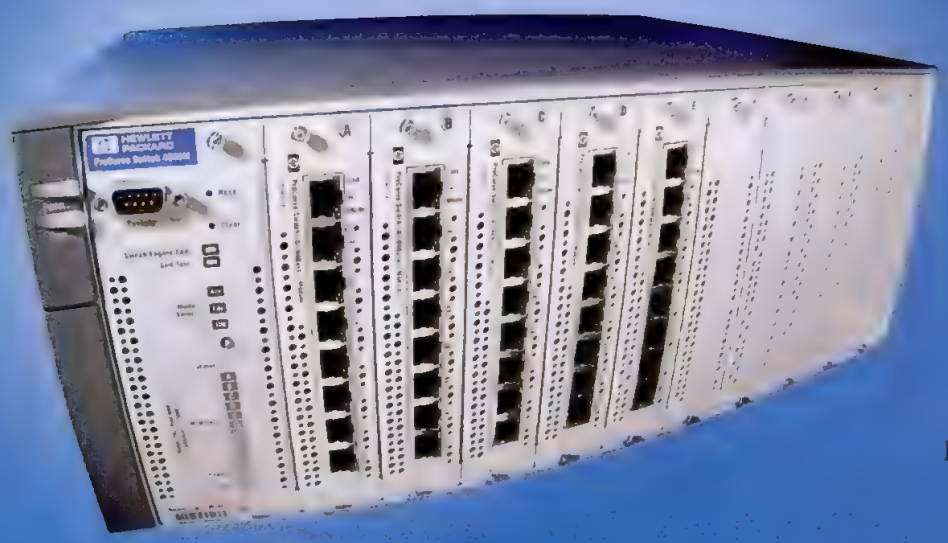

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your network, then
inform you of what they did.

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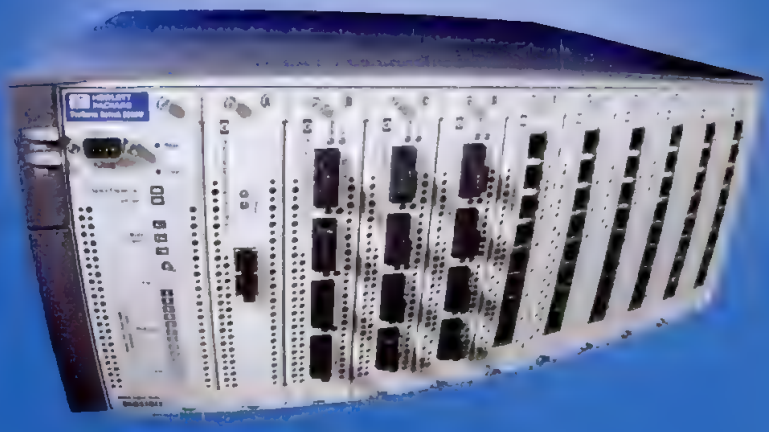

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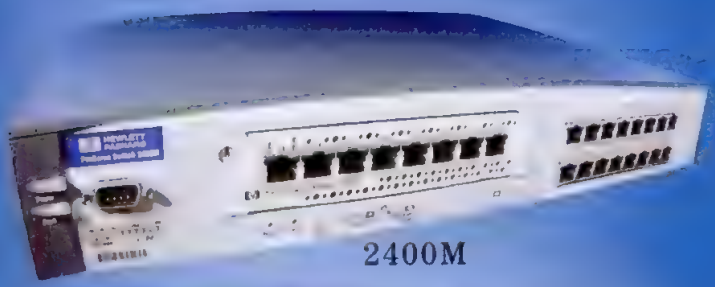

2400M

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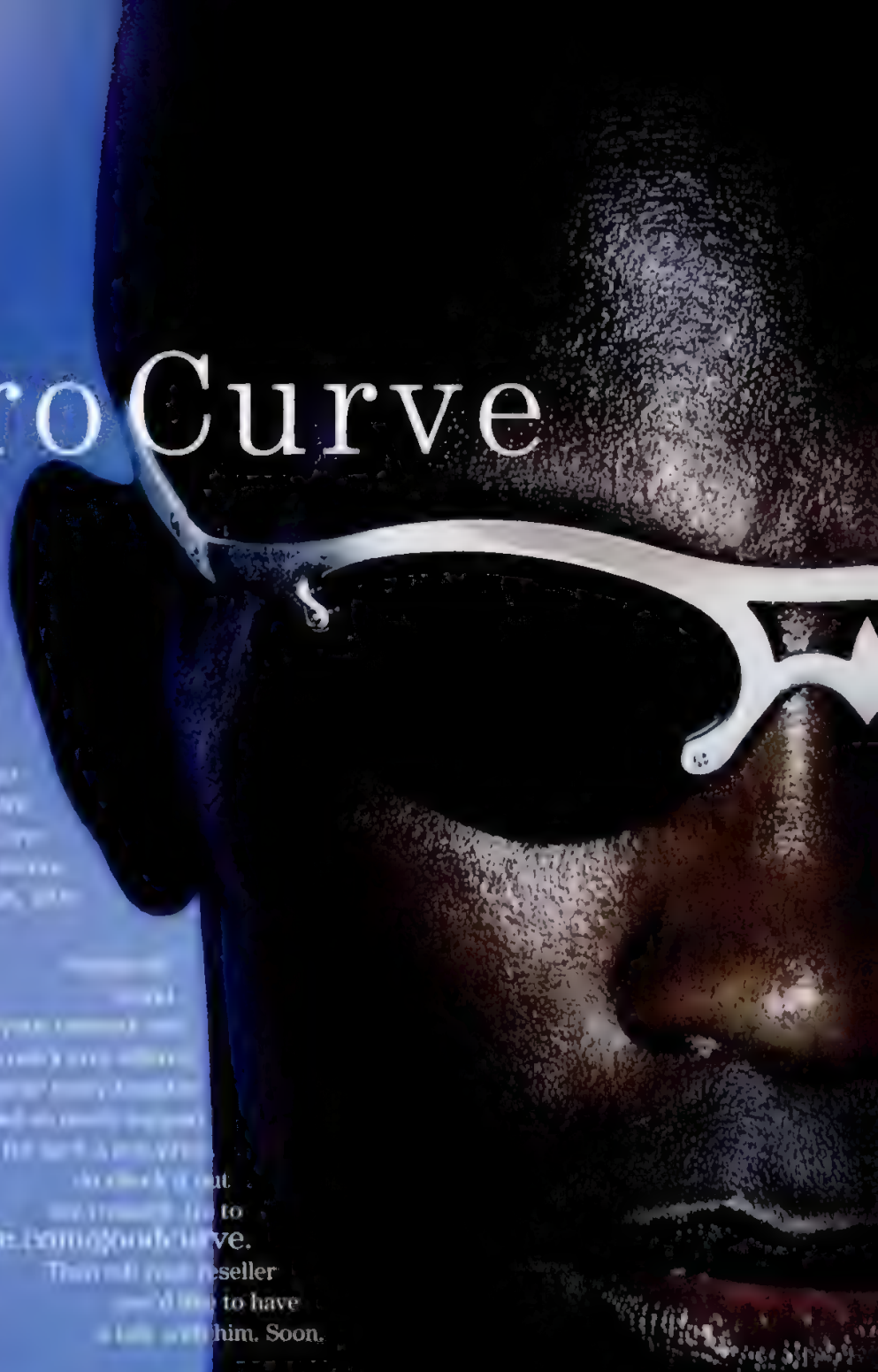

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Cisco 2924-XL	$166 per port

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Combination PC Cards

■ YES ☐ NO	Compaq Microcom 550 56K Modem + 10/100 Ethernet PC Card	IBM 10/100 EtherJet CardBus Adapter with 56K Modem	Intel PRO/100 Mobile Adapter LAN + Modem56/32bit CardBus	Ositech Jack of Spades CardBus 10/100 + 56K Modem with DPI PC Card	SysGear MultiGear MG56-10/100TX	3Com Megahertz 10/100 LAN + 56K Modem PC Card	Xircom RealPort CardBus Ethernet 10/100 + Modem 56
Street price	$300	$280	$280	$370	$290	$300	$300
Bus/Power requirement	16-bit/5.0V	CardBus/3.3V	CardBus/3.3V	CardBus/3.3V	16-bit/5.0V	16-bit/5.0V	CardBus/3.3V
Card slots occupied	One Type II	One Type II	One Type II	One Type II	One Type II	One Type II	One Type III
Supports Windows 95 / 98 / NT	■■■	■■■	■■■	■■■	■■■	■■■	■■■
Bundled software	Country select and diagnostic utility	Diagnostic utility	Country select and diagnostic utility	Communications programs and diagnostic utility	Faxing software and diagnostic utility	Communications programs and diagnostic utility	None
Size of ROM	4MB	4MB	4MB	2MB	2MB	2MB	4MB
Flash upgradable	■	■	■	■	■	■	■
Simultaneous LAN and modem use	■	■	■	■	■	■	■
NIC Features							
Controller ASIC	Xircom and Lucent Technologies	Xircom and Lucent Technologies	Xircom Dr. Pepper Rev 4	SMsC Epic-C	SysGear ASIC DL-10019	ASIC/TDK 78Q2120	Xircom and Lucent Technologies
10/100 auto-negotiation	■	■	■	■	■	■	■
Full-duplex support	■ (10 Mbps only)	■	■	■	■	■	■
Connector configuration	RJ-45 port on dongle	RJ-45 port on dongle	RJ-45 port on dongle	Direct connect proprietary cables	RJ-45 port on dongle	RJ-45 port on dongle	Internal ports
LEDs	Link integrity and transmission activity	Link integrity and transmission activity	Power, link integrity, and transmission activity	None	Link integrity, LAN speed, and transmission activity	Link integrity and LAN speed	Carrier detect, transmit/receive, LAN activity, LAN speed, and link integrity
Modem Features							
Controller ASIC	Lucent Venus 1675	Lucent Venus 1675	Lucent Venus 1675	Rockwell L2600	Lucent Venus 1675	Proprietary ASIC/TI 320C52	Lucent Venus 1675
Protocols supported	V.90, K56flex	V.90, K56flex	V.90 K56flex	V.90, K56flex	V.90, K56flex	V.90, x2	V.90, K56flex
Connector configuration	RJ-11 port on dongle	RJ-11 port on dongle	RJ-11 port on dongle	Direct connect proprietary cables	RJ-11 port on dongle	Two RJ-11 ports on dongle (one pass-through)	Two internal RJ-11 ports (one pass-through)
Data/Fax/Voice	■■	■■	■■	■■	■■	■■■	■■
LEDs	Carrier detect and transmit/receive	Carrier detect and transmit/receive	Power, link, and transmit/receive	None	None	None	Carrier detect and transmit/receive
Digital line protection/support	■	■	■	■■	■	■	■
Mobile telephone support	Digital/analog cellular and GSM	Cellular, Ericsson 688/788, Motorola and Nokia 3110/8110	Cellular, AMPS, and GSM	AMPS, Motorola and Nokia, GSM, Ericsson and Nokia	None	Cellular, AT&T, Ericsson, GE, Motorola, Nokia, RadioShack Technophone	Analog cellular, DCS 1800, GSM 900, PCS 1900
Service and Support							
Tech-support number	800-652-6672	800-772-2227	916-377-7000	888-674-8324	800-680-4327	800-638-3266	805-376-9200
Tech-support hours (eastern time)	24 hours, 7 days	24 hours, 7 days	5:00–3:00 M–F	8:00–8:00 M–F	24 hours, 7 days	9:00–8:00 M–F	9:00–8:00 M–F
Free technical support	■	■	■	■	■	■	■
Warranty (parts and labor)	3 years	Lifetime	Lifetime	5 years	Lifetime	Lifetime	Lifetime

utility for reassigning the COM port. For those who both use non-TAPI-compliant applications—the only types that have difficulty with COM5—and must have a CardBus solution, we recommend one of the alternatives from IBM, Intel, or Xircom, which all include utilities.

Although the Ositech's Fast Ethernet score of 42.0 Mbps was the lowest of the four CardBus solutions' results, it still achieved only 3 percent less throughput than the fastest card on this test (the Xircom card). More important, it produced the fastest throughput on Ethernet tests (7.7 Mbps) and an average modem throughput score (21.3 Kbps).

Combining reliable performance with unique features such as support for digital phone lines and a dongle-free design, the Ositech is one of the best choices for all of your communications needs.

SysGear MultiGear MG56-10/100TX

Type II 16-bit card; $290 street. Monrovia, CA; 800-680-4327, 626-256-3788; www.sysgear.com; 503 at www.pcmag.com/infolink.

● The 16-bit SysGear MultiGear MG56-10/100TX has few obvious flaws. But compared with the 3Com Megahertz 10/100 LAN + 56K Modem PC Card, the SysGear was simply outperformed on our network

The SysGear MultiGear MG56-10/100TX, a 16-bit card, earns high performance marks.

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tests (although both products excelled on modem tests). For those seeking a 16-bit combo card, 3Com is a better choice.

The SysGear is a 16-bit card that uses a single Type II slot with separate dongles for telephone and network cables—each with LEDs. Its modem-line dongle has digital-line protection and is larger than most units, measuring 0.8 by 1.0 by 3.5 inches (HWD). Installing the SysGear card takes about 5 minutes. SysGear bundles a communications package, called SuperFax, with the card.

After installation, both 10-Mbps and 100-Mbps network connections were detected accurately, with support for simultaneous modem and network connections. The modem was set to COM2 during installation—one of the advantages of a non-CardBus solution.

As with the other 16-bit cards, the SysGear's Fast Ethernet performance is relatively limited, with a tested throughput of 7.4 Mbps. The SysGear also lagged on Ethernet performance, posting a throughput of 5.0 Mbps. However, the Sysgear's modem throughput was better than average, with a rate of 30.2 Kbps (second only to the 3Com card). We found no compatibility problems in Windows 95, 98, or Windows NT.

Other than its larger-than-usual phone line dongle, the SysGear Multi-Gear MG56-10/100TX offers no surprises and certainly no problems. But better 16-bit choices, such as the 3Com Megahertz 10/100 LAN + 56K Modem PC Card, do exist.

3Com Megahertz 10/100 LAN + 56K Modem PC Card

Type II 16-bit card; $330 street. Santa Clara, CA; 800-638-3266, 408-326-3000; www.3com.com; 504 at www.pcmag.com/infolink.

PC MAGAZINE EDITORS' CHOICE

Of the 16-bit cards we tested, the 3Com Megahertz 10/100 LAN + 56K Modem PC Card delivered the best throughput. And although it is the most expensive 16-bit card in this roundup, it also delivers more for the money, offering two RJ-11 phone jacks on the dongle, a standard 6-foot Category 5 network cable, and an elegantly illustrated manual. All of this makes the 3Com card our top non-CardBus choice.

The 3Com card occupies a single Type II PC Card slot and uses separate dongles for network and telephone connections. Replacement dongles aren't cheap, priced at $39.95 (list) for the two-jack phone dongle and $30 (list) for the LAN connector, which has LEDs to indicate network speed and activity. The modem supports

Of the 16-bit cards we tested, the 3Com Megahertz 10/100 LAN + 56K Modem PC Card is the performance leader for both network and modem connections.

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data and fax as well as voice and includes Mobile SpeakerPhone and RapidComm Voice applications.

Installing the 3Com card took approximately 5 minutes (12 minutes when installing the two extra programs). The card successfully completed all tasks including using the modem while connected to a network, and it accurately detected a switch from an Ethernet to a Fast Ethernet LAN.

On our tests, the 3Com card was the fastest of the 16-bit cards in both Ethernet (6.4 Mbps) and Fast Ethernet (9.7 Mbps) throughput tests. In addition, it had the highest overall average throughput in modem testing at 30.6 Kbps.

Though it costs a bit more, the 3Com Megahertz 10/100 LAN + 56K Modem PC Card's combination of features and performance give it the solid, reliable feel that you expect from a LAN/WAN solution.

Xircom RealPort CardBus Ethernet 10/100 + Modem 56

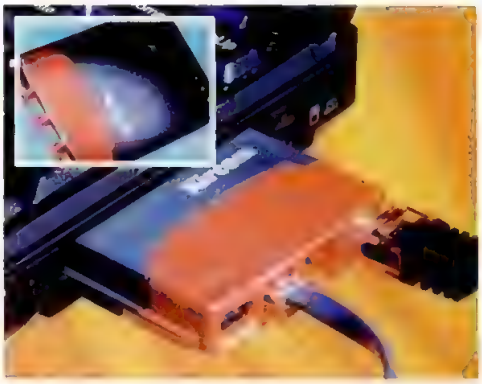
Type III CardBus card; $350 street. Thousand Oaks, CA; 800-438-4526, 805-376-9300; www.xircom.com; 505 at www.pcmag.com/infolink.

● A Type III card (occupying two slots), the Xircom RealPort CardBus Ethernet 10/100 + Modem 56 is based almost entirely on one key feature: It lets you connect without proprietary dongles or cables. Whether this translates into an advantage or a drawback, however, depends on your mobile computing needs.

The 32-bit Xircom PC Card offers two RJ-11 phone line ports, an RJ-45 10/100+ network port, a cellular or GSM telephone adapter port, and four small LED connection-speed and activity lights. Since you can plug standard network and modem cables directly into the card, this design lessens the number of pieces you need to carry. And, in case you forget or lose your cables, you can easily find a replacement. But the dual-slot requirement means that on most notebook computers, you can't insert other PC Cards while connected.

Like other CardBus modems, the Xircom selects COM5 by default. Fortunately, Xircom includes a utility that lets you change the port after installation.

The Xircom card supports simultaneous network and modem connections as well as network speed switching. Throughput performance was similar to the other CardBus cards, with a strong score (43.1 Mbps) on Fast Ethernet, but a slightly below-average score (6.4 Mbps) on Ethernet tests. Its 20.2-Kbps modem throughput was less impressive.



The Xircom RealPort frees you from having to carry dongles or proprietary cables.

The Xircom gets high marks for its innovative design. If you can live without the extra slot, it may be an attractive option. PC

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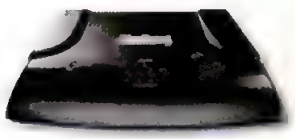

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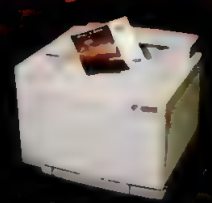

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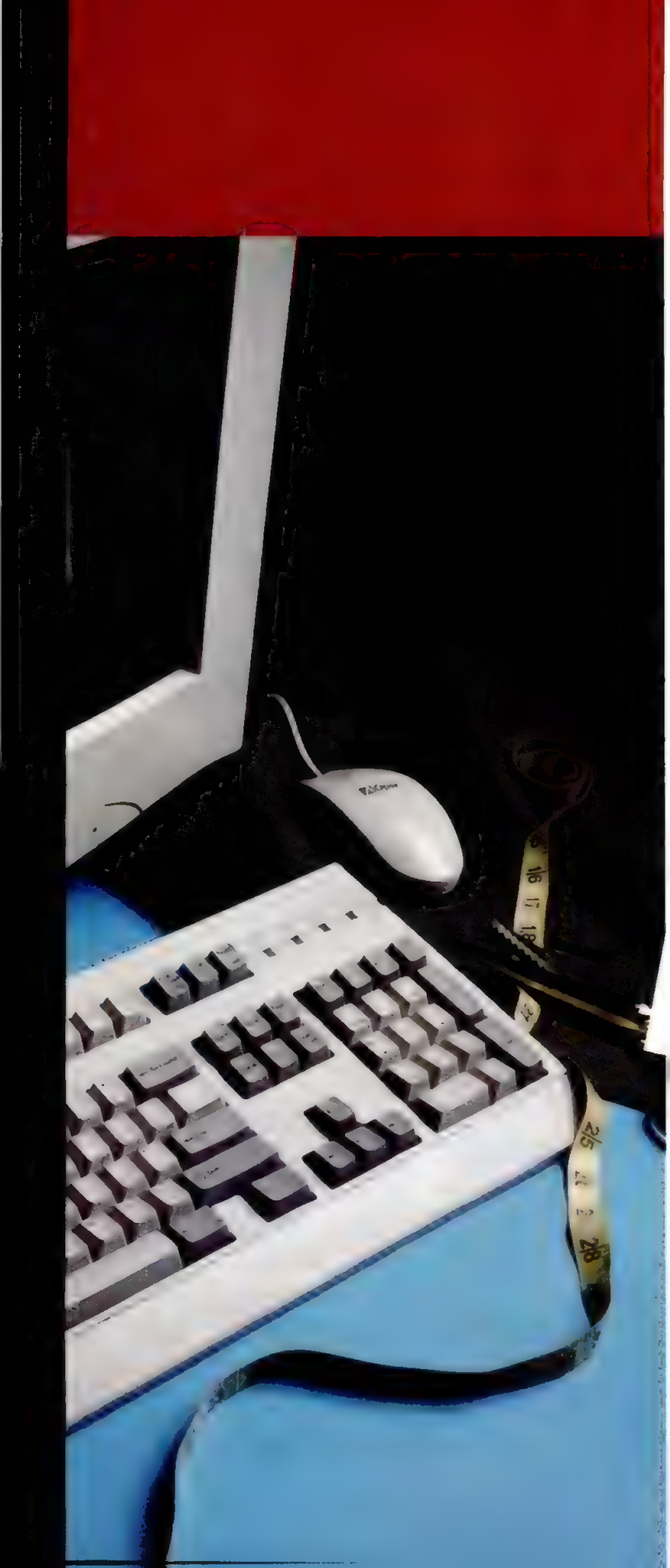

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TUTOR

Ink Jet Printers

Improvements in speed and quality, combined with bargain-basement prices, have made the ink jet a hot item.

By Alfred Poor

You probably either own an ink jet printer already or are thinking of buying one. Once limited in resolution compared with lasers and occasionally plagued by problems with image accuracy, opacity, and smudging, ink jets have been greatly refined and now dominate the personal computer printer market. And for good reason: There are full-color models available for under $100, and many ink jets now rival lasers for text quality and can produce photo-quality images. You'll get the most out of your printer if you understand how it works.

The concept of jet printers is simple—they squirt liquid ink onto paper—but they actually rely on highly sophisticated technology, in spite of their affordable prices.

THE FINE ART OF SPITTING

Current ink jet printers typically have resolutions of 600 dots per inch (dpi) or higher and print speeds approaching those of lasers when printing black and white. A fast ink jet printer can produce a full-color, 300-dpi, 8- by 10-inch image in 2 to 4 minutes. That amounts to producing 7.2 million dots in 120 to 240 seconds, or 30,000 to 60,000 dots per second. A typical ink jet printhead may have 64 nozzles for each color, so these individual nozzles must be able to cycle on and off at rates as high as 900 times per second, which is remarkably rapid for a mechanical device.

In the early days of ink jets, the printheads were designed to emit a steady stream of tiny drops of ink. The drops were charged with static electricity and were then "steered" either onto the paper or into a recycling reservoir by charged fields. This was inefficient and not altogether accurate. Today, ink jet printers rely on drop-on-demand technology, which produces single droplets when needed. There are two methods ink jets use to achieve this speedy spitting: *thermal* and *piezoelectric*.

One of the legends of computer technology explains how the thermal ink jet was invented. An engineer was experimenting with ink formulations and had some loaded in a syringe. He accidentally brushed the needle against the hot tip of a soldering iron, and a tiny drop of ink shot out.

The contemporary ink jet head uses the same principle: The ink is loaded into a tiny capillary tube, and a tiny pad rapidly heats the ink to the boiling point. This creates a tiny bubble of steam, which expands and forces a drop of ink to the end of the tube. The heat is turned off, and the ink cools, causing the steam to condense and contract and stopping the flow of ink until the next bubble of steam

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USER TO USER

Controlling Quick Launch ToolTips in Windows 98; choosing an application to open files too big for Notepad; speeding up Word 97's shutdown; automating reactions to cell changes in Excel 97; and more. *Page 235.*

UTILITIES

MailCall enhances the mail clients that come with Microsoft Internet Explorer and Netscape Navigator. You can monitor multiple accounts, view headers before retrieving messages, and launch the e-mail program of your choice. *Page 243.*

ENTERPRISE COMPUTING

Data warehousing means more than consolidating your information. Warehousing allows historical data to be extracted and analyzed in ways that help decision making. We look at various types of warehousing and offer some recommendations on which might be best for your organization. *Page 245.*

PC TECH

Distributed applications offer great advantages but present challenges in performance, reliability, and security. We show how Windows NT's MSMQ service handles them. *Page 247.*

ILLUSTRATIONS BY JEAN TUTTLE

is generated to create a drop of ink. The alternative approach is to use the piezoelectric effect, as Epson does with its ink jets.

Piezoelectric crystals have a unique and curious property. If you apply a physical force to them, they can generate an electrical charge. The process also works in reverse: Apply an electrical charge to the crystal and you can cause it to move, creating a mechanical force.

A piezoelectric ink jet printhead uses a crystal at the back of a tiny ink reservoir. A current is applied to the crystal, making it pull inward. When the current is interrupted, the crystal snaps back to its original position, forcing a tiny amount of ink out through the nozzle. When the current resumes, the crystal pulls back, poised to propel the next drop.

This approach has its advantages. Piezoelectric printheads can use ink that dries faster and pigments that might be damaged by the temperatures in a thermal head. Also, a piezoelectric printhead is built into the printer, so only the ink cartridge needs to be replaced. (Thermal ink jets incorporate the jet nozzles into each ink cartridge, which can increase the cost of the cartridge and thus the cost per page.) The downside is that if a piezoelectric printhead is damaged or clogged, the printer must be repaired.

TINY BUBBLES

Whether heat or vibration is used to generate the droplets, the result is the same: Tiny dots are placed on the paper. As the droplets get smaller, you can produce images with higher resolution and better color.

Early personal ink jet printers produced droplets that contained about 86 *picoliters* of ink each. A picoliter is one-trillionth of a liter, which means that it would take roughly 11.6 billion of these drops to fill a liter bottle. Over the years, the technology has been refined, and now ink jet droplets each contain about 10 picoliters of ink—100 billion to the liter.

These tiny droplets create marks that are about 50 to 60 microns (one-millionth of a meter) in diameter, less than the diameter of a typical human hair. The smallest-size dot that the unaided human eye can see is about 30 microns across, so these dots are approaching the limits of our perception.

The incredibly small size of these droplets makes it possible to increase the resolution of the printed output. It takes about a 35-micron dot to create an output of 720 dpi, so these drops overlap slightly at that resolution. There is more to print quality than simply resolution; other factors play important roles in how we perceive the detail in a printed image. Some printers control the shades and intensity of colors by layering up to 16 droplets in the same space. This increases the number of colors created, improves anti-aliasing (getting rid of "jaggies"), and makes smoother transitions from one color to the next.

INK SPOTS

The inks used in these printers are a lot more complex than you might think. The engineers who create them must consider a variety of factors, including drying characteristics and the pigments used. Today's inks dry faster than those used in the past. For black printing only, slow-drying inks are not too much of a problem, because text requires relatively small amounts of ink and will probably dry before the next sheet is placed in the output tray. If an image has large areas of black, however, the ink will take longer to dry and will be more prone to smudging. With color images, slow-drying inks cause major problems as the inks run together and blur the results. A fast-drying ink lets you place another drop in the same spot without blurring.

Another consideration is how the ink works with different print media. Standard copy paper is relatively porous, allowing the ink to dry faster but also causing the ink to be wicked along the paper fibers, expanding the dot size. On the other hand, overhead transparencies and some coated high-resolution papers are practically impervious to ink, and the inks must stick to the surface of the sheet yet dry rapidly enough that the image does not smudge.

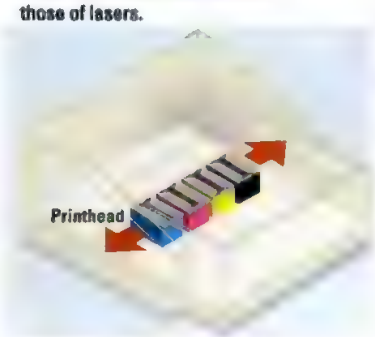
Even the dyes used in the inks make a difference. Some pigments are made up of molecules smaller than 50 nanometers (nm), or billionths of a meter. These have the advantage of creating brighter colors, but they tend to fade after exposure to bright light and are more likely to be water-soluble. These are the dyes typically used for the cyan, magenta, and yellow inks. Pigments with molecules in the range of 50 nm to 100 nm are more waterproof and stand up to light better, but they are more opaque, so they're less suited for the layering required to produce many shades of color. As a result, these are used mostly for black inks.

There are hurdles to cross before ink jets will be as fast as lasers, but don't bet against them. Their lower cost and excellent output quality have already all but eliminated impact dot matrix printers from the market, and it looks as if they will maintain their dominant position for a long time to come. PC

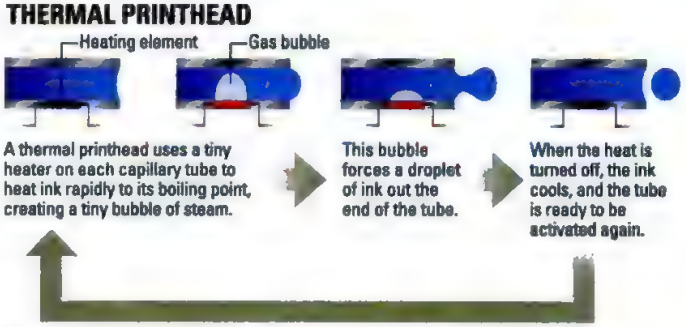
Alfred Poor is a contributing editor of PC Magazine.

Ink Jet Printers

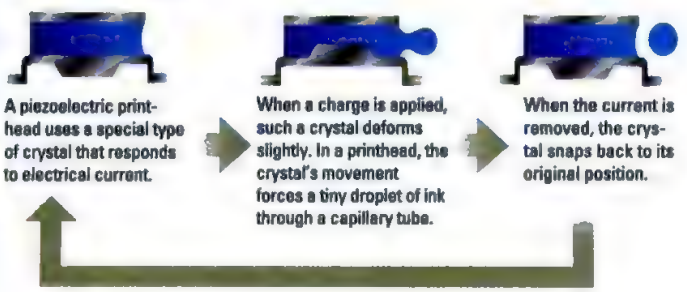
The heart of an ink jet printer is the printhead, which contains many tightly spaced capillary tubes. Tiny droplets of ink are forced out of nozzles at the ends of these tubes and land on the paper. Fast activation cycles, combined with tightly bundled nozzles and quick-drying inks, allow modern ink jets to offer resolutions of 600 dots per inch (dpi) or higher and black-and-white print speeds approaching those of lasers.



THERMAL PRINTHEAD



PIEZO PRINTHEAD



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USER TO USER

Controlling Quick Launch ToolTips

The *Quick Launch* toolbar in Windows 98 (or Windows 95 with Internet Explorer 4) actually gets its icons and ToolTips from the shortcuts stored in the folder C:/Windows/Application Data/Microsoft/Internet Explorer/Quick Launch.

So, if you drag a program to the toolbar you may end up with, for example, "Shortcut to Excel.exe" as the ToolTip. Edit the properties of the shortcut stored in the directory named above, and you can have a better icon with a more useful ToolTip, such as "Excel 97 with SR1".

Drew Dekreon
Anchorage, Alaska

PC If you've enabled User Profiles on your system, the location for the shortcuts defining the *Quick Launch* toolbar will be C:\Windows\Profiles\username\Application Data\Microsoft\Internet Explorer\Quick Launch, where "username" is your user name. And, of course, if your Windows folder is something other than C:\Windows, the path to the location will begin with your particular Windows folder. However, you don't actually have to know either of these names. To work with the shortcuts in the *Quick Launch* toolbar, simply right-click the vertical "grab handle" at the left end of the toolbar and choose *Open* from the pop-up menu. This will also work for any user-defined toolbar and for the built-in *Links* toolbar. So, for example, renaming "Launch Internet Explorer Browser.lnk" to "Launch IE4.lnk" will change the text and ToolTip of the corresponding toolbar icon (Figure 1).

You can reduce the space used for a toolbar by suppressing its title and the titles of its icons. Right-click the toolbar's grab handle and remove the check marks in the pop-up menu next to *Show Title* and *Show Text*. You can still see the text for any of the icons; it appears as a ToolTip when you rest the mouse cursor over the icon. Note also that changes made to the *Links* toolbar will be mirrored in the *Links* toolbar within Internet Explorer 4. If the *Links* toolbar isn't visible, right-click the taskbar, choose *Toolbars* from the pop-up menu, and put a check next to *Links*.

—Neil J. Rubenking

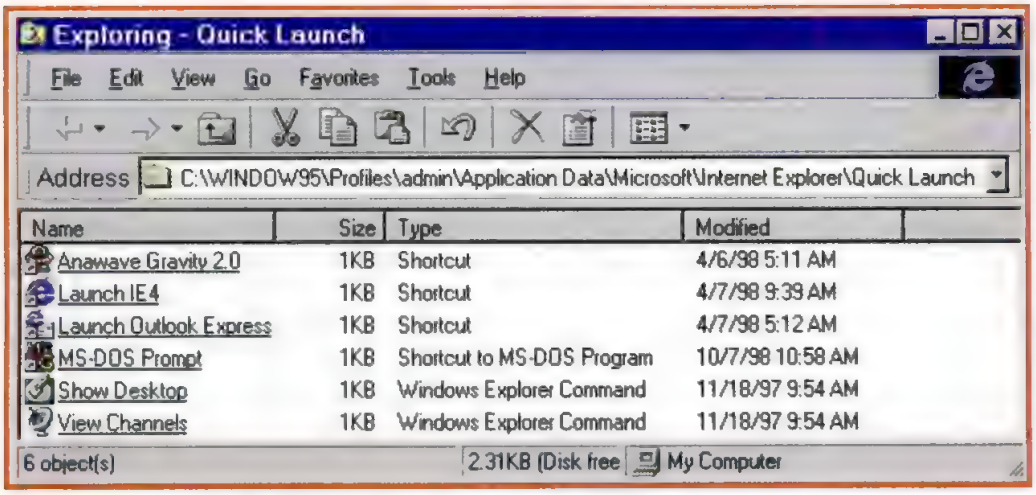

FIGURE 1: *The text and ToolTip for an icon in the* Quick Launch *toolbar can be controlled by changing the name of the corresponding shortcut.*

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Dealing with Files Too Large for Notepad

When I double-click a large text file, I get the following message: "This file is too large for Notepad to open. Would you like to use WordPad to read this file?" How do I change my system settings so it prompts me to use Microsoft Word instead of WordPad?

Tom Monaco
via the Internet

PC You can't change the prompt, but you can change the behavior with a minor tweak to the Registry. Launch Regedit and navigate to the key `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\App Paths\WORDPAD.EXE`. In the right-hand pane, double-click the (Default) value to edit its data. Replace the existing data with the full pathname of the program you want Notepad to launch in place of WordPad for text files that are too large.

This change should not affect the *Start* menu link to WordPad, as that link is normally created using the full pathname of the WordPad program. But if you type *wordpad* in the *Start* menu's *Run* dialog box, Windows will launch the program you specified in the `App Paths` Registry key.

Readers occasionally write us with a related question: They want WordPad to take over when Notepad can't handle a large file, but it fails to do so. This problem occurs because the Registry entry for WordPad no longer matches the actual location of WORDPAD.EXE. You can use the same technique described here to restore the normal interaction between Notepad and WordPad.

—Neil J. Rubenking

Configuring DOS-Mode Drivers

I have some programs that I still need to run in DOS mode, and they require that I access my CD-ROM drive and mouse. The problem is that I need to know exactly what to put in my Config.sys and Autoexec.bat files to get this hardware to work when I reboot in DOS mode. Can you help?

Brandon Czarnocki
Austin, Texas

PC Unfortunately, there is no way to give a precise answer, because not all CD-ROM drives use the same CD-ROM drivers. The best we can offer is a generic answer that should provide enough detail to get you to the point where you can work out the specifics on your own. You may need this information even if you don't think you do; the Windows emergency boot disk does not add these drivers, so without making these modifications, you will not be able to access your CD-ROM drive to restore files if you lose your hard disk and have to boot from the floppy.

Under Windows 95 or Windows 98, the operating system can automatically provide virtual-mode drivers for the CD-ROM drive and mouse (and other devices). These will still be accessible when you open a DOS window, but if you reboot in DOS mode, these devices must rely on real-mode drivers, which are loaded in your Config.sys and Autoexec.bat files. You can add the required lines to these files in the Exit to Dos.pif file, or you can add them to a boot floppy.

To Config.sys, you add the line

```
DEVICE=[cdromdriver.sys] /D:[driveid]
```

To Autoexec.bat:

```
[path]MSCDEX /D:[driveid] [path]MOUSE
```

The `[cdromdriver.sys]` parameter in the Config.sys file is the CD-ROM device driver, and you should have received a copy of this with the drive. If you don't have the file, you can contact the drive manufacturer—the company Web site is a good place to start—to see whether there is a copy available that you can download. Failing that, you can try some of the generic drivers available at sites such as *www.windrivers.com/*.

The `[driveid]` parameter in both the CD-ROM device driver and the `MSCDEX` lines must match. Typically, you can use a combination of letters and numbers, and most installations default to ID values like MSCD001. If these ID values do not match, MSCDEX will not find the drive's device driver.

MSCDEX is Microsoft's program CD-ROM Extensions, which provides access to a CD-ROM in DOS. It should be installed in your Windows/Command folder by default. The file also is included on the Windows 95 CD in the Win95_04.cab file and on the Windows 98 CD in the Base5.cab file.

Mscdex.exe also has a number of other parameters that you can use. The one you are most likely to want is the `/L:[driveletter]` switch, which lets you assign a specific drive letter to the CD-ROM drive.

To access the mouse, you'll need another real-mode driver. Again, your system's mouse should have come with an executable program (such as Mouse.com) or a driver with a .sys extension that can be loaded with a `DEVICE=` line in the Config.sys file. If not, you can try using the Mouse.com that was included by Microsoft in Windows 3 and DOS 6 versions, if you should have one of those operating systems available in your archives.

Once you have these lines installed in your boot floppy or Exit to Dos.pif files, be sure to test them carefully, especially if you are modifying your emergency boot disk. Make sure that the files give you access to your CD-ROM drive and mouse now, and don't wait until you need them to find out whether or not the modified boot files work.—*Alfred Poor*

> Make sure you can get DOS access to your mouse and CD-ROM drive now; don't wait until you need them to see if they'll work.

When Word 97 Takes a Long Time to Close

Since upgrading to Microsoft Office 97, I've found that Word takes an inordinate amount of time to close—sometimes over a minute with only one document window open. It also takes up to 15 seconds to load the first document after launching, even though later documents load virtually instantaneously. This is particularly annoying since Office 95 ran extremely well on this system, which is a Pentium MMX/233 with 64MB of EDO RAM and a Western Digital 1.6MB hard disk. Is the problem simply that Word 97 is unreasonably slow, or is there something I can do to speed it up, particularly for closing documents?

M. L. Pershern
via the Internet

PC Sluggish closing of files is probably the single most common complaint from Microsoft Word users who upgrade to Office 97. The slowdown comes from a feature that many users—perhaps most—don't even realize exists.

Microsoft Outlook offers a feature called the Journal, which can track several kinds of events on your system. By default, one of the things it keeps track of is everything you work on in Word. Whenever you work on a document, the Journal records the filename, the time you created or opened it, and the length of time you've worked on it. You can view the details as Journal entries in Outlook 97 by choosing *Go | Journal* or by clicking on the Journal icon in the Outlook bar to go to the Journal.

The Journal records these entries whether Outlook is loaded or not, and very likely it records them even if you've never bothered to open Outlook at all. Alas, if you aren't interested in using the Journal, the time it takes to write the entries to disk is simply unwanted overhead.

For reasons that aren't at all clear, the overhead can be virtually unnoticeable on some systems but annoyingly time-consuming on others. Whatever the difference is, it isn't simply a matter of CPU speed and RAM. My test-bed, for example is a 90-MHz Pentium with 48MB of RAM. That's severely underpowered compared with the Pentium MMX/233 with 64MB of RAM mentioned in the letter, but closing Word on my test-bed with a file open takes only a second or two—even with the overhead of a Journal entry—compared with the times of over a minute mentioned in the letter.

Fortunately, if the overhead is bothersome on your system, there's an easy way to turn the feature off. Open Outlook and choose *Tools | Options*, then *Journal*. You'll see a number of check boxes for items to track, including one for Microsoft Word. Remove the checks from all of the check boxes and the sluggishness of closing programs should disappear.

Don't be in too much of a hurry to turn off this feature if you don't see noticeable sluggishness on your system. In addition to tracking the amount of time you work on your files, the Journal also creates a shortcut to the document as part of each entry. This can be a lifesaver if you've forgotten where you've saved a file.

To find a misplaced file, you can load Outlook and open the Journal. To see a list of entries if one isn't already showing, choose *View | Current View | Entry List*. To limit the list to Microsoft Word documents, choose

View | Filter and then *Journal Entries*, set *Journal Entry Type* to *Microsoft Word*, and choose *OK*. Then click on the *Start* heading at the top of the *Start* column to sort by date and time, and browse though the *Subject* column to find the document you're looking for. Double-click on the document name to open the Journal entry so you can see the shortcut to the file. Double-click on the shortcut, finally, to open it in Word. *—M. David Stone*

Automated Reactions to Cell Changes

In cell A1 of an Excel 97 spreadsheet, I have a remote-reference formula (for a stock market quote) whose value gets updated every few seconds. When the value of A1 changes, I would like to copy the values of cells B2:G2 into A2:F2. At the same time, I'd like to copy the new value of A1 into G2. Is it possible to automate this with a macro?

Rudy Pauls
Toronto, Ontario

PC In a new VBA module, enter the following code:

```
Public Flag as Integer
Sub DoIt()
Range("b2:g2").Cut
Destination:=Range("a2:f2")
    Range("g2").Value =
Range("a1").Value
    Flag = 0
End Sub
```

Then, in the VBA Editor's *Project Explorer* window, double-click the entry for the worksheet you're using—*Sheet1*, for example, if the worksheet where all this action is to take place happens to be Sheet1. You should now see two drop-downs at the top of the code window. One is called *(General)*; the other is called *(Declarations)*. In the first drop-down, choose *Worksheet*. In the second, choose *Change*. Now the following lines appear in the code window:

```
Private Sub Worksheet_Change(ByVal
Target As Excel.Range)
End Sub
```

Between these two lines, type

```
If Flag = 0 And Target.Cells(1, 1) =
Range("a1") Then
    Flag = 1
    DoIt
End If
```

The `Worksheet_Change` procedure triggers the `DoIt` procedure whenever a change occurs in cell A1. The DoIt procedure does the cutting, copying, and pasting. The `Public Flag` variable, shared between the two procedures, ensures that the whole operation occurs only once with each change to A1. Without this, Excel seems to regard the copying of A1 into G2 as a change to A1—and repeats the `DoIt` procedure endlessly. *—Craig Stinson*

Automating Access's Compacting Process

I have a database-compacting program that uses a DOS batch file to make a copy of the database and delete the temporary database (if one exists) and then uses Access code to repair the database and compact it into a temporary database. Another batch file then copies the compacted database using the original database name. It works, but the process is not as smooth as I would like. The problem is that the Access code does not wait for the DOS commands to complete before continuing. This prevents me from automating the whole process.

Dennis Miller
Grand Island, Nebraska

PC If you're using Microsoft Access 95 or later, you can automate the process using VBA code instead of a batch file. An example appears in Figure 2. Regarding the batch file, however, if you're running Windows 95 or 98 you can use the `start` command with the `/w` switch to execute Access. The `start` command starts the named application, and the `/w` switch tells the command to pause and wait for the application to complete before continuing. Thus you can do something like this:

```
start /w c:\access\msaccess.exe
nwind.mdb /compact tempp.mdb
```

This starts MS Access and automatically invokes the compact process, producing from Nwind.mdb a compacted database named Tempp.mdb. The command does not complete until Access is finished compacting and shuts down. You then have to delete the original database and rename the compacted database with the original name. You should also precede the `start` command with a `copy` command that makes a backup copy of your database, just in case.

You're better off creating a separate data-

```
Function CompactMdb(strMdb As String) As Boolean
    Dim strFileName As String, strCompacted As String, strBackup As String
    On Error GoTo CompactMdbErr
    ' First backup the database.
    strFileName = Left(strMdb, InStr(strMdb, ".mdb") - 1)
    strBackup = strFileName & "Backup.mdb"
    FileCopy strMdb, strBackup          ' Make a backup.
    ' Next compact the database.
    strCompacted = strFileName & "Compacted.mdb"
    DBEngine.CompactDatabase strMdb, strCompacted ' Compact to new file.
    ' Next delete the old and rename the new.
    Kill strMdb                         ' Delete the old uncompacted database.
    Name strCompacted As strMdb         ' Rename compacted database to original
    ' name.
    CompactMdb = True
CompactMdbExit:
    On Error Resume Next
    Exit Function
CompactMdbErr:
    MsgBox "Error number " & Err.Number & ": "
& vbCrLf & Err.Description, , "CompactMdb"
    CompactMdb = False
    Resume CompactMdbExit
End Function
```

You can call the CompactMdb VBA function from your Access application to compact a Jet database.

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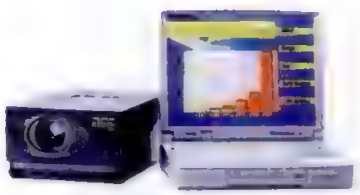

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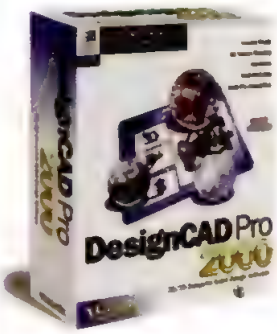

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base for the purpose of compacting your application database. Once you've created the new database, enter the `CompactMdb` function in Figure 2. The code relies upon the Microsoft Jet database engine's `CompactDatabase` method to compact the database. You pass `CompactMdb` the name of the database to compact, such as `C:\My Documents\Northwind.Mdb`, and it goes ahead and does the compacting along with all of the surrounding housekeeping. First it makes a backup copy of the named database. Then it does the compact. Then, if the compact has succeeded, it deletes the original database and renames the compacted database with the original name.

You could call the `CompactMdb` function from a button on a form, for example, or in event code attached to a form's On Open event. You could add `Application.Quit` to the end of the event code to force Access to shut down automatically after `CompactMdb` completes. Finally, you could make the form automatically appear at start-up (see *Tools | Startup*), after which it would automatically run the code and exit. Thus double-clicking on the database in Windows would automatically cause the form to perform the compact operation and then exit.

As of this writing, Microsoft hopes to let you automatically compact a database upon closing it in Office 2000. In the meantime, however, if coding VBA functions or DOS batch files is not your thing, you can also consider a third-party product called Total Access Agent ($199), from FMS. Total Access Agent lets you schedule and automatically perform various administrative tasks, including compact and repair. FMS can be reached at 888-220-6234, 703-356-4700, or *www.lfmsinc.com*.
—Sal Ricciardi

SOLUTIONS

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Downloading Acrobat Files Direct to Disk in IE

I use Microsoft Internet Explorer as my Web browser. When I click on a hyperlink that leads to an Adobe Acrobat PDF file, Acrobat 3.0 automatically loads and displays the file as it's received. I'd rather download the file to my hard disk and view it later, but I can't figure out how. Is there a way?

Ken Richardson
New York, New York

PC It's not obvious, but you can indeed download the file directly to your hard disk for later viewing. When you install Acrobat, the Version 3.0 installation program places a small ActiveX control in your Acrobat3\Reader\Activex folder. When you click on a hyperlink that leads to a PDF file, the Acrobat ActiveX control takes over and launches the Acrobat Reader to do the work of displaying and managing the PDF file within an Internet Explorer window. Unfortunately, the reader doesn't offer a menu option for downloading the PDF file to disk.

The trick is to right-click the hyperlink that leads to the PDF file instead of left-clicking to bring up the Reader. A context menu like the one shown in Figure 3 will appear. Next, choose *Save Target As . . .* and enter a filename in the resulting dialog. Don't forget to give the file a .pdf file extension. Then choose *OK* to close the dialog; the file will be downloaded.

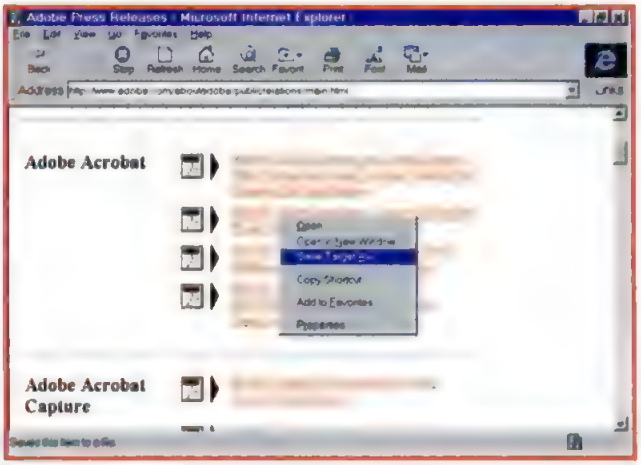

FIGURE 3: *You can download an Acrobat PDF file directly to disk by right-clicking on the hyperlink that leads to the PDF and choosing* Save Target As . . . .

If you always want the choice of either viewing or downloading the PDF file, you can set this up by making some changes to your system configuration. Because this involves editing the Windows 95 registry, I recommend the following only to readers who are experienced in the fine art of registry editing and who have safe backup copies of their registry files. You should probably check with your system administrator, if you have one, before you attempt this procedure.

You can edit the registry using Registry Editor (Regedit.exe), but be sure to make backup copies of the two registry files, User.dat and System.dat, before you begin.

First, open up a Windows Explorer window and look at the files in your Acrobat3\Reader\Activex folder. There will be a file named either Pdf.ocx, Pdf41.ocx, or Pdf42.ocx. Write down the name of the one you have. This is the Acrobat Reader ActiveX control.

Next, select the *Start* menu, choose *Run*, and then type the command that follows, changing the name of the OCX file to the one installed on your system. If you installed the Acrobat Reader in a folder other than the default location, change the command to match your installation. This step unregisters the Acrobat ActiveX control:

```
regsvr32.exe -u
c:\acrobat3\reader\activex\pdf.ocx
```

When you're finished typing, press Enter to run the command. You should see a message that this step has successfully completed.

Next, to run Registry Editor, select the *Start* menu, choose *Run*, enter *Regedit.exe*, and then press Enter. When Registry Editor loads, look for the following key:

```
HKEY_CLASSES_ROOT\MIME\Database\
Content Type\Application/pdf
```

If the key exists, select it, then select the *Edit* menu and choose *Delete*. When you're asked to confirm, choose *Yes*. Next, look for the following key:

```
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\
Internet Explorer\Plugins\MIME\
Application/pdf
```

If the key exists, select it, then select the *Edit* menu and choose *Delete*. When you're asked to confirm, choose *Yes*. Now select the *Registry* menu and choose *Exit*.

Note that if you have Netscape Navigator or Netscape Communicator installed, you will also have to delete the file Nppdf32.dll, located in Navigator's Program\Plugins folder. This is because Internet Explorer will attempt to load the Navigator plug-in when it doesn't find a registered Acrobat ActiveX control.

That's it. Now when you click on a hyperlink that leads to a PDF file, you'll be asked whether you want to open the file or save it to disk. If you choose *Open*, the Acrobat Reader will take over and you can view the file. If you choose *Save*, you'll be asked to enter a filename and the PDF file will be downloaded to disk.—*Sal Ricciardi* PC

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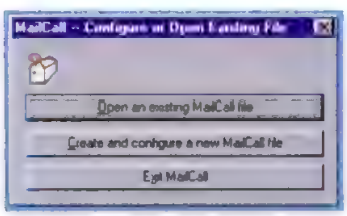
MailCall Monitors Incoming E-Mail

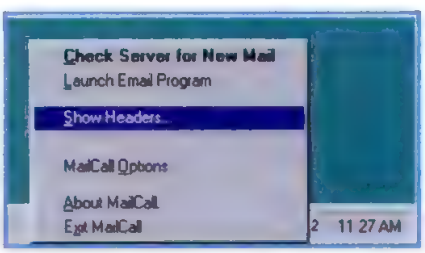
Microsoft Internet Explorer and Netscape Navigator each come with a bare-bones e-mail notification feature. *PC Magazine*'s e-mail notifier, MailCall, is a significant enhancement over the included browser options. MailCall lets you monitor multiple e-mail accounts, view message headers before retrieving messages, and launch the e-mail program of your choice.

MailCall runs under Windows 95, Windows 98, and Windows NT 4. An article about how to use MailCall and how it was written is available on our Web site at *www.pcmag.com/pctech/index-ut.html*. A link for downloading the utility and its source code can also be found here.

John Deurbrouck, the author of MailCall, is a longtime Windows programmer and a frequent contributor to PC Magazine. *Sheryl Canter is the editor of the Utilities column and a contributing editor of* PC Magazine.

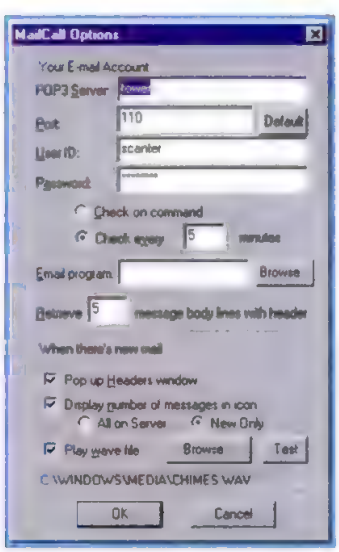


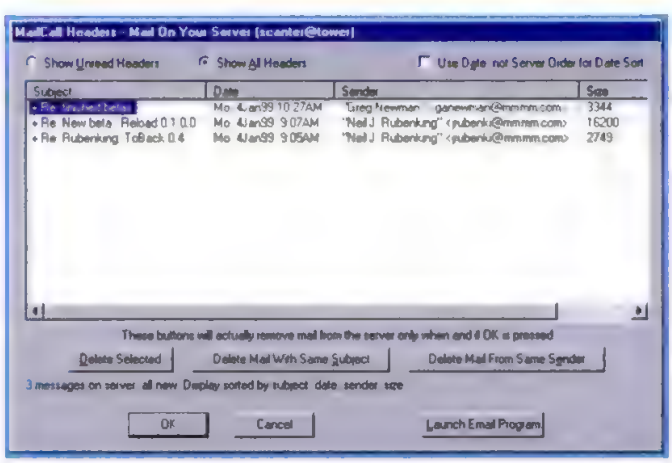
It's easy to configure MailCall to monitor multiple accounts. When you launch the program, you can choose a configuration file or create a new one.



You access MailCall through its tray icon. Here, the icon is the number 2 (next to 11:27 AM, lower right) to indicate that two messages are waiting on the server. If you double-click the tray icon, MailCall will immediately check for new messages.

You specify configuration file settings in the Options *dialog. To notify you of new mail, MailCall can pop up a header display window, show the number of messages in its tray icon, play a WAV file, or do all three.*





The header display window lets you see who has sent you mail and the size of each message. You can launch your e-mail program from here, or you can delete the messages without retrieving them.

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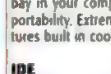

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9100MB	7200	Quantum	VK309100W	$389
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Data Warehousing: An Overview

By Gabrielle Gagnon

Data warehousing is the technology trend most often associated with enterprise computing today. The term conjures up images of vast data banks fed from systems all over the globe, with legions of corporate analysts mining them for golden nuggets of information that will make their companies more profitable.

All of the developments in database technology over the past 20 years have culminated in the data warehouse. Entity-relationship modeling, heuristic searches, mass data storage, neural networks, multiprocessing, and natural-language interfaces have all found their niches in the data warehouse. But aside from being a database engineer's dream, what practical benefits does a data warehouse offer the enterprise?

When asked, corporate executives often say that having a data warehouse gives them a competitive advantage, because it gives them a better understanding of their data and a better understanding of their business in relation to their competitors, and it lets them provide better customer service.

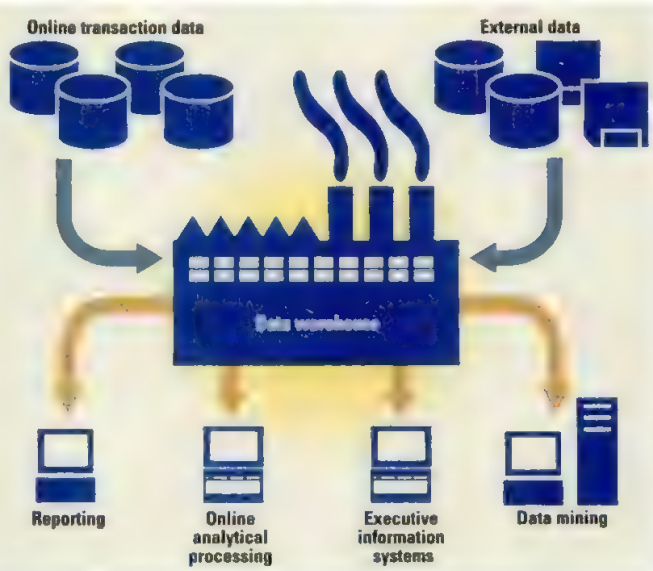
So what exactly is a data warehouse? Should your company have one, and if so, what should it look like?

Essentially, a data warehouse provides historical data for decision-support applications. Such applications include reporting, online analytical processing (OLAP), executive information systems (EIS), and data mining.

According to W.H. Inmon, the man who originally came up with the term, a data warehouse is a centralized, integrated repository of information. Here *integrated* means cleaned up, merged, and redesigned. This may be more or less complicated depending on how many systems feed into a warehouse and how widely they differ in handling similar information.

But most companies already have repositories of information in their production systems, and many of them are centralized. Aren't these data warehouses? Not really.

Data warehouses differ from production databases, or online transaction-processing (OLTP) systems, in their purpose and design. An OLTP system is designed and optimized for data entry and updates, whereas a data warehouse is optimized for data retrieval and reporting, and it is usually a read-only system. An OLTP system contains data needed for running the day-to-day operations of a business, but a data warehouse contains data used for analyzing the business. The data in an OLTP system is current and highly volatile, with data elements that may be incomplete or unknown at the time of entry. A data warehouse contains historical, nonvolatile data that has been adjusted for transaction errors. Finally, since their purposes are so different, OLTP systems and data warehouses use different data-modeling strategies. Redundancy is almost nonexistent in OLTP systems, since redundant data complicates updates. So OLTP systems are highly normalized and are usually based on a relational model. But redundancy is desirable in a data warehouse, since it simplifies user access and enhances performance by minimizing the number of tables that have to be joined. Some data warehouses don't use a relational model at all, preferring a multidimensional design instead.



TYPES OF DATA WAREHOUSES

The type of data warehouse an organization adopts should depend on the way the business operates and the types of decision support it needs.

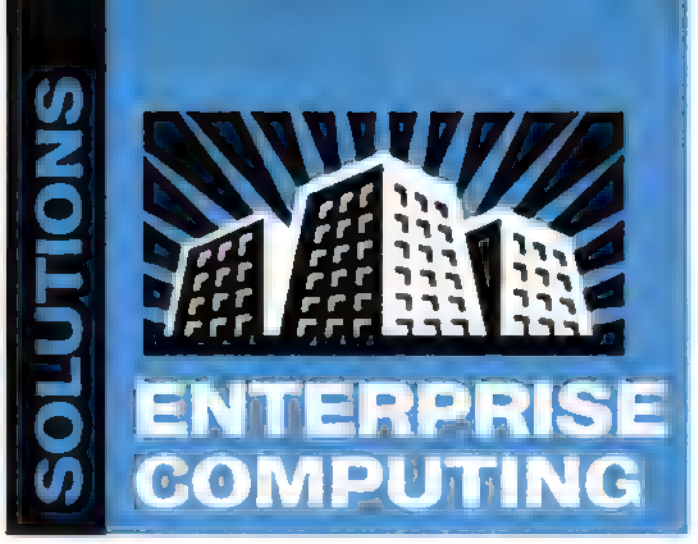
One of the simplest types of data warehouse, an *operational data store* (ODS) is a replicated production database that has been adjusted for errors. An ODS is used primarily to generate standard operations reports and to provide transaction detail for summary-level analysis. (Since an ODS replicates an OLTP system, some experts don't consider it a true data warehouse type. We've included it in our discussion, however, because ODSs fit the broad definition and many data warehouses contain them.)

Depending on an organization's reporting needs, an ODS may be updated monthly, weekly, or more frequently, sometimes almost in real time. Its main advantage is that it enhances production system performance, since reporting and query functions are off-loaded from the OLTP system to the ODS.

If your organization just generates operational reports and does little analysis or marketing research, an ODS may well suit your needs. On the other hand, if your company handles relatively few transactions per day, an ODS may be overkill. You can use the production system to generate reports instead.

Another type of data warehouse is the *data mart*. Data marts are limited in scope, usually taking their information from a single department or business process. They may be used for analyzing sales information in a specific region or for a particular product line, for example. Data marts usually contain only summary data, but they can be linked to operational data stores for drilling down to transaction details if necessary. They are sometimes managed by IT departments, but just as often they are managed directly by users in a department or work group.

While many OLAP applications can be performed on data marts, cross-departmental analysis, executive information systems, and data-mining applications need information gathered from the entire enterprise to be most effective. The *enterprise data warehouse* is used for this type of extensive data collection and analysis. Because of its scope and com-



plexity, the enterprise data warehouse is usually managed by the central IT group.

As its name implies, an enterprise data warehouse contains information taken from throughout an organization. This is the most complex type of warehouse to build and maintain, since data must be merged from multiple systems into common subject areas.

Different systems often produce incompatible or inconsistent data, and sometimes the data must undergo several transformations before it can be integrated into a data warehouse in a meaningful way. Inmon estimated that 80 percent of the time, building such a data warehouse would be spent on extracting, cleaning, and loading data.

If your organization can benefit from data mining, building an enterprise data warehouse may be well worth the effort. Data-mining tools work with various statistical techniques for modeling data and for estimating and predicting outcomes based on what they have learned. They work best with large data sets.

There are many ways to build an enterprise data warehouse. One form uses a centralized approach, combining all the enterprise's data in a single, large data store. Another form takes a distributed approach, pulling data from multiple data marts.

DATA WAREHOUSE COMPONENTS

Although a data warehouse sounds like a single entity, it is really a multitiered, multiapplication conglomerate that comprises several components. Each component may be handled by one or more pieces of hardware or software. No vendor has a complete data warehouse package.

Functionally, a data warehouse extracts data from operational systems and loads it into a holding area where it is "scrubbed" (that is, made to conform with warehouse standards), merged, time-stamped or dated in some way, and loaded into databases for use by data access tools.

Since data goes through a number of transformations and is ultimately placed in data structures different from the ones it came from, those changes are mapped in catalogs or dictionaries. Such catalogs are managed with metadata tools. Data that defines or describes data in the warehouse is called *metadata*. There are typically two kinds of metadata. Things that users need to know, such as table and column names and definitions, are called *frontend metadata*. Everything else, such as how a particular data element maps to its original database, is *backend metadata*.

Design and management tools are also important components of a data warehouse. Even though it contains nonvolatile data, a data warehouse is far from static; you can't just build one and forget about it. A data warehouse is a high-maintenance system that expands as the company's demands on it increase. Even if the design of the warehouse itself changes little, the designs of the production systems that feed it are likely to change. These changes must be captured in the data warehouse metadata. Unlike an OLTP system, which gives a snapshot of the present, a data warehouse is meant to provide a complete picture of the data over time. This means that whenever any data structure in a production system changes, you have to capture both the change and when it occurred in the warehouse; otherwise queries against historical data may yield peculiar results.

> The average cost of building a data warehouse has been estimated at $2.2 million, but the ROI is 40 percent or more.

PRACTICAL CONSIDERATIONS

Time and money. In a 1996 study published by IDC ("A Study of the Financial Impact of Data Warehousing," IDC, 1996), the average cost of building a data warehouse was $2.2 million, with an average time of 2.3 years to break even. Ninety percent of the companies in the study achieved greater than 40 percent return on investment (ROI), and 50 percent achieved over 160 percent ROI. The average ROI over three years, cumulative, was about 400 percent, with a higher ROI for data marts. Clearly, building a data warehouse can be profitable, but it's not a quick hit. Your company should be aware of the amount of investment likely before any payback can be expected.

Space. Data warehouses require lots of disk space. When estimating how much storage space you'll need, don't look at just the current production systems. Remember that you'll be building a system of historical data. Most organizations will want to keep at least a year's worth of data, and if you want to do any kind of trend analysis, you will need several years. Also, reports and analysis usually need more than one index. Be generous in your estimates of disk space. Data warehouses measured in terabytes are not unusual, and some large organizations are even using petabytes. (A petabyte equals 1,024 terabytes.)

Consolidation. Combining data from multiple sources may reveal incompatibilities or problems with your OLTP systems. Consistency is especially important for data-mining applications, since most data-mining tools teach themselves how to analyze the data by looking at it. You may need either to do extensive data scrubbing or to fix the OLTP systems. Talk to users about their data needs, and decide whether the result justifies the cost.

Security. Security considerations for data warehouses are different from those for OLTP systems. For a data warehouse to pay for itself, lots of users have to be able to benefit from it, and therefore more users will need access to data than are traditionally authorized by OLTP security. According to experts, a "right to know" mind-set must prevail over the "need to know" philosophy, which would restrict access to data warehouses and minimize their effectiveness. If your organization can't make that cultural change, a data warehouse may be a wasted investment.

User-friendliness. Data warehouses have to be user-friendly. Since a data warehouse is not a production system, users don't have to use it. And the fastest, most reliable system won't be used if the user doesn't understand it or finds it cumbersome to work with.

Project planning. A data warehouse sometimes takes years to implement. Before embarking on a data-warehousing project, determine what your business objectives for it are, what the potential costs are versus the benefits, what resources you'll need, and how much organizational commitment you'll need. Without good planning and user buy-in, the project is not likely to be successful.

As more and more corporations come to appreciate that the information they gather each day is an asset, they will rely more and more on data warehousing. But while a data warehouse can provide managers with the means to ask questions of their data and get back meaningful answers, it can't automatically make a company more profitable. A good technology can't substitute for good management. Whether a data warehouse becomes a valuable strategic tool or an expensive white elephant depends as much on the organization using it as on the technology. PC

Gabrielle Gagnon is a free-lance journalist and frequent contributor to PC Magazine.

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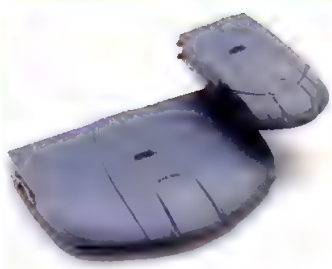

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Improving the Performance of Distributed Applications

By John Lam

The increased interest in distributed-applications programming, coinciding with the growth of the Internet, has contributed to the spread of technologies such as Distributed COM (DCOM), Common Object Request Broker Architecture (CORBA), and Enterprise Java Beans (EJB). All of these protocols foster object-oriented remote procedure call (ORPC) programming, a powerful programming model that allows developers to create distributed applications with relative ease. What these protocols have in common is the notion of location transparency, an abstraction that lets a programmer call methods on an object without knowing where that object actually resides. Programmers thus can continue to program within the context of a familiar model. To make the programming model more accessible, however, the underlying protocol has had to become much more complex, resulting in performance degradation. Unfortunately, ORPC encourages a style of programming that does not mesh well with the demands of a distributed application.

When used correctly, object-oriented programming has demonstrated its superiority over earlier development paradigms by simplifying the development of complex applications. Object-oriented programs are very chatty by nature, frequently sending messages between different objects. Therefore, object-oriented programming requires the critical assumption that the amount of time that it takes to call a method on another object is essentially none. This directly contradicts the distributed applications programming model, where the amount of time that it takes to call a method on a remote-object computer is *very great.* Recent experience shows that an applications programmer must be aware of this cost difference.

In distributed applications, the cause of most performance problems is the amount of time it takes for a network round-trip (latency). It takes at least one physical network round-trip to transmit a message, and often many more, depending on the underlying network protocol being used. Thus, the goal of distributed-systems designers typically has been to minimize the number of messages required to do a given operation. But minimizing messages to improve performance (that is, combining messages) generally plays havoc with most object-oriented designs. This creates a fundamental tension between adherence to a pure object-oriented programming model and the real-world requirement of performance.

In addition to performance issues, a distributed application must also contend with a multitude of failure possibilities. In contrast to older applications that run within a single process on a single computer, a distributed application has multiple potential points of failure. Distributed applications must contend with such issues as network brownouts, server crashes, server unavailability, and client operating-system failures. The common point of failure in all of these cases is the transmission and receipt of messages between the components of the distributed application.

If transparent ORPC calls are not the solution, then what is? The answer is an operating-system service that facilitates the *reliable* transmission and receipt of messages. Such a service would allow the applications developer to focus on business issues rather than infrastructure issues. Furthermore, if the operating system could provide an additional level of indirection (a queue), then a number of auxiliary problems (load balancing, prioritization, and disconnected operation) could also be solved.

The operating-system service in the Windows NT environment that facilitates the reliable exchange of messages in a distributed environment is Microsoft Message Queue Server (MSMQ). MSMQ makes it very obvious to applications developers that they are sending messages to remote components of their applications. By doing so, MSMQ forces them to think consciously about designing their applications for distribution.

In this article we'll take a look at the MSMQ infrastructure. We'll see how distributed applications run by exchanging messages and how MSMQ facilitates message exchange between applications. We'll also show how MSMQ provides a direct method for writing applications that locate queues on a network and exchange messages using various messaging guarantees. We'll examine why security is important in distributed applications, and scrutinize the underlying security infrastructure in MSMQ, which makes it possible to write secure, distributed applications. Finally, we'll investigate how MSMQ allows you to write cross-platform distributed

ILLUSTRATION BY CHRISTIAN CLAYTON

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A MESSAGING INFRASTRUCTURE

MSMQ is a service that facilitates reliable machine-to-machine communications. To understand this service better, let's draw some parallels between MSMQ and existing e-mail systems, which are used to facilitate human-to-human communications.

MSMQ mirrors much of the e-mail messaging infrastructure provided by the Internet. Internet e-mail uses Domain Name Service (DNS) as a directory service for name lookups. Simple Mail Transfer Protocol (SMTP) is a store-and-forward infrastructure for sending messages. Post Office Protocol (POP) and Internet Message Access Protocol (IMAP) represent queues for message retrieval. MSMQ is a messaging infrastructure that provides all of the above plus some additional guarantees that are required by distributed applications. Let's take a look.

Directory services operate within a defined scope, much as a telephone directory is valid only for a given town or city. A directory service allows senders to locate receivers via meaningful names and translates these names into physical-machine addresses. In the case of Internet e-mail, DNS allows messages to be sent, for example, to *jlam@iunknown.com* rather than *jlam@207.112.35.180*.

An MSMQ *enterprise* represents the scope of the MSMQ directory service, which is called the Message Queue Information Store (MQIS) and is divided into one or more *sites* (Figure 1). Each site is defined as being a group of interconnected computers that share a high-speed network. Sites are joined by network connections called *links*. As these links may be transient connections or public networks, such as the Internet, MSMQ allows you to assign routing costs for each link.

The MQIS provides directory services for an MSMQ enterprise. In particular, the MQIS allows you to look up the names of all *public* queues within the enterprise. Just like DNS, the MQIS is a distributed database that supports decentralized administration. Multiple copies of the MQIS are stored in different computers throughout an enterprise. A master copy is stored in a computer known as a *primary enterprise controller* (PEC). Ownership of queues is determined on a site-by-site basis. At each site, a computer known as a *primary site controller* (PSC) manages its portion of the MQIS. Only a queue's PSC can update or change its portion of the MQIS. When a change (add, delete, modify) occurs at a PSC, that change is automatically replicated to all other PSCs in the enterprise.

In a busy network, the directory service (or the network that connects the directory service and its clients) can easily be overwhelmed by lookup requests. This is why MSMQ divides an enterprise into multiple sites and provides each site with its own read-only copy of the MQIS. If the lookup requests at a site become overwhelming, MSMQ supports the notion of a backup site controller (BSC), which enables load-balancing and failover schemes to be implemented on a site-by-site basis.

Currently, MSMQ requires SQL Server 6.5, because the MQIS is implemented using a replicated, distributed SQL Server 6.5 database. This restriction will be lifted in Windows NT 5.0, where MSMQ will integrate with the Win NT 5 Active Directory.

The MSMQ application programming interface (API) offers a number of functions that allow you to submit queries to the MQIS. Queues can be selected based on unique queue identifiers (128-bit globally unique identifiers, or GUIDs), user-defined labels, queue creation date or time, queue modification information, or a user-defined grouping of queues called a *service type*.

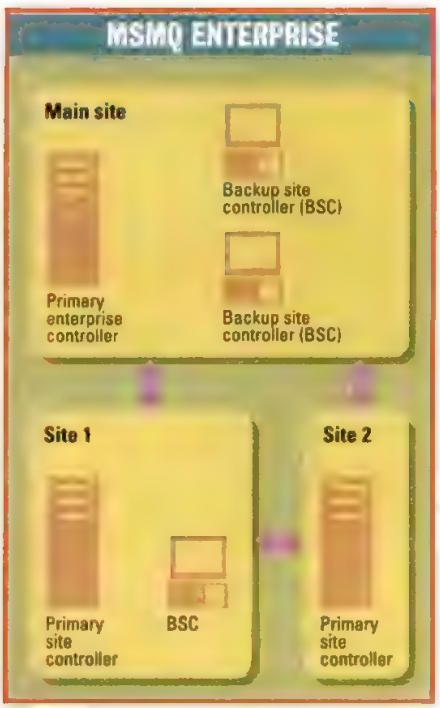

FIGURE 1: *The Message Queue Information Store is bounded by the MSMQ enterprise, which is subdivided into one or more MSMQ sites.*

The MQIS can also be bypassed completely by opening a queue directly. Looking up queues in the MQIS provides a useful level of indirection, allowing changes to the locations of queues to be isolated from clients that wish to use the queues. However, there are times that queues should be opened for direct access (such as access by a computer that is not within the MSMQ enterprise). In these cases, MSMQ allows the opening of a queue directly by specifying the name of the queue and name of the computer on which it resides.

Client applications that make use of MSMQ need to have some form of MSMQ messaging infrastructure installed on their computers, just as Internet e-mail client applications need a messaging infrastructure. MSMQ clients can be divided into two categories: dependent clients and independent clients. A dependent client always relies on a connection to an MSMQ server machine. In this case, a client application can send messages to an MSMQ queue only when there is an active connection between the client computer and the MSMQ server. The advantage of having a dependent client is that the resource constraints for the client computer are significantly reduced. The disadvantage is that the dependent client must be permanently attached to an MSMQ server, which has a limitation of 15 dependent clients.

An independent client can operate in a disconnected mode. Messages sent from client applications are stored locally on the independent-client computer for later forwarding to an MSMQ server. This is particularly useful where the client computers are frequently disconnected from the network, as is the case with notebook computers and Windows CE 3.0 devices. And it offers the advantage of allowing disconnected users to continue to do work as if they were connected to the network; that work automatically flows to the network server computers when the network connection is restored.

Both dependent and independent clients communicate with queues that are located on MSMQ servers. PEC, PSC, and BSC computers can all function as queue servers, but the requirements of a site may make it desirable to include computers whose only role is to host queues. Such computers are known as *MSMQ routing servers*.

MSMQ server computers manage their queues using a service known as the *Local Queue Manager* (LQM). The LQM is responsible for accepting and prioritizing messages from MSMQ clients. It is also responsible for storing each message in a local queue, if that is the destination, or routing that message to a

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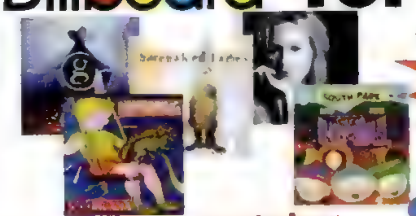

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queue on the appropriate computer on the network (Figure 2).

MESSAGING

Distributed applications pass messages between code running on different computers, either synchronously or asynchronously. With a synchronous exchange, both the sender and the receiver must be running at the same time. This is the model implied by traditional ORPC programming. The asynchronous model, on the other hand, allows the sender and the receiver to be running at *different* times provided some kind of intermediary—a queue—holds a copy of the message. The notion of a queue is at the heart of a message-queuing application. Senders send messages to a named queue rather than directly to the receiving application. Receivers open that named queue to remove messages for further processing. Reliable delivery of messages to and from these named queues is handled by the messaging infrastructure itself, MSMQ.

We regularly see examples of queues every day—an e-mail in-box, for example. Messages arrive periodically, and you respond (or not!) to each as you see fit. You can assign different priorities to the messages and respond to them in priority sequence. You can forward messages to another by placing them in *his* queue. And some messages are addressed not directly to you but to a group of which you are a member, so anyone in the group can process those messages. The powerful abstraction provided by a queue is what allows you to build distributed applications whose components are truly independent of each other.

MSMQ allows three possible results of message transmission. The first is that the message is sent *at least once*. The second is that the message is sent *at most once*. The third is that the message is sent *exactly once*. These possibilities define what happens in a failure condition, and it is absolutely essential that both the sender and the receiver agree on which one is tolerable. The trade-off is between the simplicity of the failure model and the speed of message delivery.

The first condition to consider is that of *at least once* message delivery, which occurs when you choose MSMQ's *recoverable delivery* option. In this case, a message is persisted to disk while en route to the destination queue, guaranteeing the message will not be lost. However, since messages are not delivered within the scope of a transaction, if the queue's message-receipt acknowledgment message is lost, the message will be retransmitted. Potentially, this process could create duplicate copies of a message in the queue. Stamping each message with a unique identifier allows your application to detect duplicate messages in the queues. This delivery mode provides an intermediate level of performance.

The second condition to consider is *at most once* message delivery, when you choose the *express delivery* option. This mode allows faster delivery of messages, as the messages themselves are not persisted to disk while en route to the destination queues, but it also implies that a failure would result in the loss of the message. It should be noted, however, that certain categories of messages (such as notification messages) can be lost without affecting the overall behavior of an application.

The simplest condition is that of *exactly once* message delivery. If a message is sent to a *transactional* queue, the sender is guaranteed that the message will be delivered to the queue once and only once. This is due to the atomic property of transactions, which guarantees that either a transaction succeeds as a unit or it fails as a unit. This is by far the slowest of the three modes of message delivery, since explicit confirmation of the delivery of the message to the MSMQ infrastructure is required. It is most useful in cases where you need explicit guarantees that a message has been sent to a queue within the scope of a transaction that also performs additional work (such as writing to a database). It eliminates the need to write the rollback code in the event of failure of either the database write or the message-sending operation.

The MSMQ infrastructure is responsible for delivering the message from the sender to the queue and from the queue to the receiver, regardless of the selected mode of message delivery. MSMQ does not attempt to provide an end-to-end transactional guarantee in the case of messages sent to or from transactional queues. The idea behind this is that transactional throughput is increased by keeping transactions as brief as possible, to minimize the amount of time shared resources are held within the scope of a transaction. MSMQ thus guarantees only that a message has been delivered to the local MSMQ infrastructure, *not* that it has arrived at the destination queue. Similarly, receiving applications can retrieve messages only from transactional queues that reside on their machines; they *cannot* perform remote transactional reads against queues that reside on other machines.

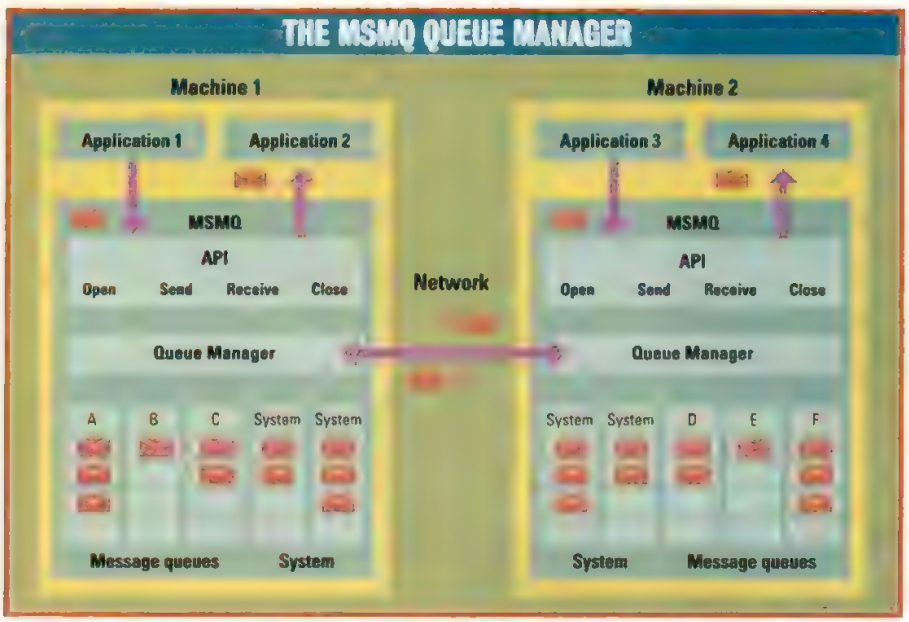

FIGURE 2: *The MSMQ Queue Manager exposes an API that accepts messages for delivery from applications, and it allows applications to retrieve messages from queues located locally or on other computers.*

SECURITY

The security of an application running on a single computing node essentially involves limiting access to that node. In a distributed environment, however, applications transmit information over networks. Without security, this information can be accessed by others. In order to ensure protection, the messaging infrastructure itself must be intrinsically secure.

MSMQ supports secure transmission of messages. There are two important meth-

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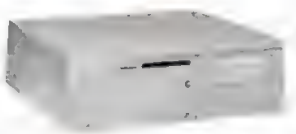

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ods for transmitting a secured message. The first is *authentication*, which verifies the identity of the sender. The second is *encryption*, which ensures that the message cannot be read by unauthorized receivers. MSMQ fully supports authenticated and encrypted messages.

Before discussing how MSMQ authenticates and encrypts messages, let's look at the two general encryption schemes in use today: *symmetric* and *asymmetric*. Symmetric encryption schemes use the same key for encryption and decryption, whereas asymmetric encryption schemes use different keys. Both schemes rely on the strength of the keys, not on the secrecy of the algorithms used to perform the encryption. The algorithms themselves have been subject to public scrutiny by the cryptographic community, and their strengths and limitations are reasonably well understood.

With symmetric encryption schemes, it is assumed that both the sender and the receiver have copies of the same key for encrypting and decrypting a message. The main advantage of symmetric encryption schemes is the speed with which clear text can be converted to or from cipher text; symmetric encryption algorithms operate nearly 1,000 times faster than asymmetric encryption algorithms. The main weakness is the difficulty of ensuring the safe transfer of the symmetric key.

Asymmetric encryption schemes use public/private key pairs. They exploit a defined mathematical relationship between the public and private keys. This relationship is based on the notion that multiplying two prime numbers to generate a new number is computationally easy, but factoring the resultant number to rediscover the original pair of prime numbers is computationally quite difficult. Thus a message encrypted using a public key can be decrypted *only* using the corresponding private key, and vice versa. Typically, a public key is used to encrypt a message and its corresponding private key to decrypt the same message. The main drawback to asymmetric encryption schemes is the high computational cost of the encryption/decryption algorithms.

MSMQ uses a combination of asymmetric and symmetric encryption schemes to provide maximum performance without compromising security. It uses symmetric encryption to encrypt the body of the message and asymmetric encryption to ensure the integrity of the transfer of the symmetric key. Let's examine how MSMQ does this by looking at the transfer of an encrypted message.

Suppose that Alice wishes to send a message to a queue named Bob. Alice wants to make sure that only people who retrieve messages from the Bob queue can read her message. Alice creates an `MSMQMessage` object and sets the `PrivLevel` property of that message to `MQ_PRIV_LEVEL_BODY`. If Alice wants to be able to set the encryption algorithm that will be used to encrypt the message, she can also set the `EncryptAlgorithm` property of the message to `MQMSG_CALG_RC4` or `MQMSG_CALG_RC2`. She opens the Bob queue using the MSMQ API and sends a message to it.

Under the hood, the MSMQ Queue Manager calls the `CryptGenKey` Crypto-API function to generate a random symmetric key and uses it to encrypt the body of Alice's message. Next it looks up Bob's public key in the MQIS, encrypts the symmetric key using Bob's public key, and attaches the encrypted symmetric key to the message. The MSMQ Queue Manager then sends Alice's encrypted message to the Bob queue. When the MSMQ Queue Manager on the computer where the Bob queue is located receives Alice's encrypted message, it

- regenerates the symmetric key using Bob's private key,
- decrypts the body of the message using the symmetric key, and
- stores that message in clear text within the Bob queue.

> The main drawback to asymmetric encryption schemes is the high computational cost of the algorithms.

Although this scheme ensures that the message gets from Alice to the Bob queue *without* being read or modified while in transit, there are two additional problems that must be considered. First, how does the MSMQ Queue Manager on Alice's computer know that the public key that it has retrieved from the MQIS was actually Bob's public key and not some impostor's? Second, how does the application that retrieves Alice's message from the Bob queue know that Alice sent the message, not some impostor?

The first problem is guaranteeing the authenticity of Bob's public key. Suppose that Mallory, a malicious agent, was able to intercept the Queue Manager on Alice's computer's initial request to the MQIS for Bob's public key. Mallory would substitute his public key for Bob's public key. MSMQ would then wind up encrypting Alice's symmetric key using Mallory's public key instead of Bob's. If Mallory were capable of intercepting Alice's subsequent message to Bob, then Mallory would be able to read its contents by regenerating the symmetric key using his private key.

Digital certificates are commonly used to solve this problem. Suppose that Alice trusts Trent, who represents a higher authority. Also, suppose that Trent is so ubiquitous that *everybody* knows who Trent is, and more important, *everybody knows what Trent's public key is*. The role of Trent is commonly held by a certificate authority, such as VeriSign. In an MSMQ enterprise, that role can be held by a server that is capable of dispensing digital certificates, such as Microsoft Certificate Server. Suppose that Trent encrypts Bob's public key using his private key. This means that anyone who (a) trusts Trent and (b) knows what Trent's public key is would be able to compute Bob's public key.

Going back to the example of Mallory, we can note that since Mallory does not know what Trent's *private* key is, there is no way that Mallory can substitute his public key for Bob's public key. Also, since Trent is such a widely trusted authority, it is highly unlikely that Mallory could successfully compromise Trent's public key *everywhere*.

The second security issue to contend with is how the receiver of a message knows that Alice sent the message, not Mallory. This problem is also easily solved through a combination of digital certificates and asymmetric encryption. For example, Alice digitally signs her message by setting the `PROPID_M_AUTH_LEVEL` property of the message to `MQMSG_AUTH_LEVEL_ALWAYS`. The MSMQ Queue Manager will use a message digest algorithm, such as MD2 or MD5, that generates a 128-bit number based on the contents of the message. It then encrypts this message digest using Alice's private key, which can be found in Alice's digital certificate. Any recipients of Alice's message can decrypt the message, compute their own message digests, decrypt Alice's message digest (using Alice's public key from her digital certificate), and compare the values. If these values match, then the recipients know that Alice sent the message.

When you're designing distributed systems, it is important to take time to think about the security infrastructure requirements up front. Remember that if messages contain sensitive

information, they should be both authenticated and encrypted to prevent eavesdropping or tampering while they're in transit. MSMQ provides the necessary infrastructure to allow easy authentication and encryption of messages in a distributed application.

HETEROGENEOUS COMPUTING

As we noted above, location transparency is a major strength of the ORPC protocols, but this is also what makes it exceedingly difficult to enable cross-platform computing using ORPC as the foundation. Consider the case of Distributed COM. One of DCOM's strengths is that it imposes a *binary* object model. This means that DCOM defines what an object is at a binary level and also provides the necessary infrastructure to ensure that method invocation is transparently remoted over the network. For this to work, however, DCOM must be highly dependent on the operating-system infrastructure services that lie underneath. In fact, DCOM is extremely tightly coupled to its underlying platforms, Windows NT and Windows 9*x*.

DCOM relies on the operating system to provide threading support, remote procedure call services, security services, and a local directory service (the registry). To port DCOM to another platform would require a duplication of all of these services on the target operating system. Needless to say, this would require a huge development effort.

A far simpler solution is to port MSMQ independent clients to other platforms rather than porting DCOM. Since MSMQ is concerned only with *messaging* and not with method invocations, the amount of infrastructure modification required by MSMQ is significantly less, as is the amount of infrastructure support. This simplifies its implementation on platforms with more stringent hardware requirements. MSMQ independent client support has been announced for Windows CE 3.0, where implementing the Microsoft RPC infrastructure would have increased the footprint of the operating system by an unacceptable amount. MSMQ also lets you extend the reach of distributed applications to legacy systems. For example, Level 8 Systems (*www.level8.com*) promises MSMQ independent client support for a wide range of computing platforms through its FalconMQ product suite.

MSMQ provides an effective solution for integrating applications and solving performance problems in today's distributed-computing environments. The MSMQ programming model makes it very obvious to the applications developer that he is invoking functionality in remote portions of his distributed application. MSMQ provides an infrastructure that enables reliable, secure interapplication messaging. The infrastructure components themselves are simple enough to be easily ported to different platforms, thereby allowing message delivery to and from applications that are running on different computing platforms.

FURTHER READING

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Bruce Schneier, *Applied Cryptography*, 2nd Edition (Wiley, 1996; ISBN: 0-471-12845-7). PC

*John Lam researches distributed-computing issues and developed the Essential Web Applications course at DevelopMentor (*www.develop.com*).*

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#30976	780DVD	233 PII MMX	64	5.1GB	DVD	13.3" TFT	56K	$2,959
Portege Series								
#34810	7000CT	266 PII MMX	32	4.3GB	—	12.1" TFT	56K	$2,558
#39052	3010CT	266 MMX	32	4.3GB	—	10.4" TFT	56K	$1,695
Satellite Series								
#34758	4000CDT	233 PII MMX	32	4.1GB	24X	12.1"	56K	$1,595
#37253	4010CDS	266 PII MMX	32	4.1GB	24X	12.1" DSTN	56K	$1,529
#37260	4010CDT	266 PII MMX	32	4.1GB	24X	12.1" TFT	56K	$1,797
#37261	4020CDT	300 PII MMX	64	6.4GB	24X	13.3" TFT	56K	$2,417
Libretto								
#39002	110CT	233 MMX	32	4.3GB	—	7.1" TFT	—	$1,697

UMAX ActionBook 330T

- Pentium 233MHz Processor
- 32MB RAM expandable to 84MB
- 3.2GB HD
- 13.3" Active Matrix Display
- 56K Modem
- 20X CD-ROM

$1,399 #30805

IBM ThinkPad 390

- 233MHz Pentium® processor w/MMX™ technology
- 32MB
- 3.2GB HD
- 24X CD-ROM
- 12.1" TFT display
- 56Kbps Modem

$1,599 #37639

Order#	Model	Pentium® processor	RAM	HD	CD	Display	Modem	Price
#35175	TP390Z	233 PII MMX	32	4.0GB	24X	12.1" HPA	—	$1,799
#35180	TP390Z	300 PII MMX	32	4.0GB	24X	12.1" HPA	—	$1,949
ThinkPad 560								
#35329	TP560X	233 PII MMX	32	4GB	—	12.1" TFT	56K	$1,999
#35338	TP560X	300 PII MMX	64	6.4GB	—	12.1" TFT	56K	$2,489
ThinkPad 600								
#35187	TP600	266 PII MMX	64	5.1GB	24X	13.3" TFT	56K	$3,239
#35193	TP600	266 PII MMX	64	6.0GB	DVD	13.3" TFT	56K	$3,329
ThinkPad 770								
#30325	TP770E	266 PII MMX	32	5.1GB	—	14.1" TFT	33.6K	$3,759
#30327	TP770ED	266 PII MMX	64	8.1GB	DVD	14.1" TFT	56K	$2,749
ThinkPad 390								
#38168	TP390	233 PII MMX	32	3.2GB	24X	14.1" TFT	56K	$1,699
#38171	TP390	266 PII MMX	64	4.3GB	24X	14.1" TFT	56K	$2,279

*Windows 98

SONY VAIO 505F

$1,549 #36519

- 233MHz Pentium processor w/MMX™ technology
- 32MB RAM
- 4GB hard drive
- V.90 Modem ▮ Win 98
- 10.4" Active Matrix Display
- 0.9" thin, less than 3lbs.

Order#	Model	Processor	RAM	HD	Display	Modem	O/S	Price
#37588*	PCG505G	200P MMX	32	2.1GB	10.4" TFT	56K	Win 98	$1,299

*Factory refurbished

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- MS Office 97 SBE V2

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Order#	Model	Processor	RAM	HD	CD	Display	Modem	O/S	Price
Prosignia SMB									
#38829	120	233 PII MMX	32	3.2GB	24X	12.1" TFT	56K	Win 98	$1,949
#38854	140	266 PII MMX	32	4GB	24X	13.3" TFT	56K	Win 98	$2,399
#38855	160	300 PII MMX	32	6GB	24X	14.1" TFT	56K	Win 98	$2,899
Armada 1700 Series									
#33230	1700	233 PII MMX	32	4.0GB	24X	12.1" TFT	56K	Win 98	$2,149
#33235	1700	266 PII MMX	32	4.0GB	24X	13.3" TFT	56K	Win 95	$2,799
#35391	1700	300 PII MMX	32	5.0GB	24X	14.1" TFT	56K	Win 95	$3,429
New Armada 7800 Series									
#35469	7800	300 PII MMX	64	8.0GB	DVD	14.1" TFT	—	Win 95	$4,849
Armada 3500 Series									
#35380	3500	266 PII MMX	32	4.1GB	—	12.1" TFT	—	Win 95	$2,799
#35381	3500	300 PII MMX	64	6.4GB	—	13.3" TFT	—	Win 95	$3,859

COMPAQ Presario 1235

$1,299* 266MHz AMD-K6™ Enhanced Processor #35011

- 32MB RAM ▮ 12.1" HPA Display
- 4GB HD ▮ 56Kbps Modem
- 24X CD-ROM ▮ Windows 98

Order#	Model	Processor	RAM	HD	CD	Display	Modem	O/S	Price
#40901	1255	333 AMD-K6-2	32	4.0GB	24X	12.1" TFT	56K	Win 98	$1,499
#40904	1260	333 AMD-K6-2	64	4.0GB	24X	12.1" TFT	56K	Win 98	$1,799
#42171	1920	300 PII	64	6.4GB	2X-DVD	13.3" TFT	56K	Win 98	$2,999

*$100 mail-in rebate from Compaq upon sign-up for 50-hour free trial of Compaq Easy Internet Access

COMPAQ Prosignia SMB

- 350 or 450MHz Pentium II processor w/MMx technology
- 64MB exp. to 384MB
- 10GB Ultra ATA hard drive
- 40X or DVD - ROM
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- 56K Modem

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Deskpro EP Series								
#36236	4300	350 PII MMX	64	4.3GB	—	T/D	Win 95	$1,149
#36314	10000CDS	400 PII MMX	64	10.0GB	32X	T/D	Win 95	$1,589
#36315	10000CDS	450 PII MMX	64	10.0GB	32X	T/D	Win 95	$1,699
#42177	10000CDS	400 Celeron MMX	64	6.4GB	—	T/D	Win 95	$1,319
#42176	4300	400 Celeron MMX	32	4.3GB	—	T/D	Win 95	$1,019

T/D=towerable design

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- 10MB ROM
- 56K Modem

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- 56Kbps modem
- Windows 98

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Order#	Model	Processor	RAM	HD	CD	Modem	Form	System	Price
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#40837	5220	380 AMD-K6-2	64MB	8.0GB	32X	56K	MT	Win 98	$999
#42254*	5240	400 AMD-K6-2	64MB	10GB	40X	56K	MT	Win 98	$1,199
#37441	5190	400 AMD-K6-2	128MB	12GB	DVD	56K	MT	Win 98	$1,199
#40895	5670	450 PII MMX	128MB	19GB	DVD	ADSL	MT	Win 98	$1,999

37441 includes an Iomega Zip drive.
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- Windows 98

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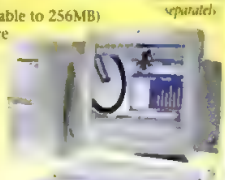

Starting at $899 #41175

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#41204	6460	400 Celeron	96MB	9.6GB	32X	56K	Win 98	$1,199
#41203	6470Z	400 PII MMX	96MB	12.7GB	32X	56K	Win 98	$1,599
#42286*	8396	450 PII MMX	128MB	10.2GB	DVD	56K	Win 98	$1,499
#42296*	6360	366 AMD K6-2	64MB	9.6GB	24X	56K	Win 98	$799
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#36604	627525U	333 Celeron	32MB	3.2GB	32X	W98	$1,049
#36607*	628513U	333 Celeron	32MB	3.2GB	—	W98	$899
#36590	627557U	350 PII	32MB	3.2GB	—	W98	$1,049
#36612	627575U	450 PII	64MB	6.4GB	32X	NT	$1,849
#36613	627574U	450 PII	64MB	6.4GB	—	NT	$1,549
#33327	627555U	350 PII	32MB	3.2GB	—	NT	$1,099
#33328	627556U	350 PII	64MB	3.2GB	—	NT	$1,149
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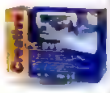

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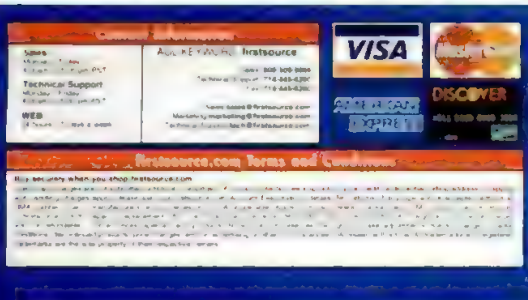

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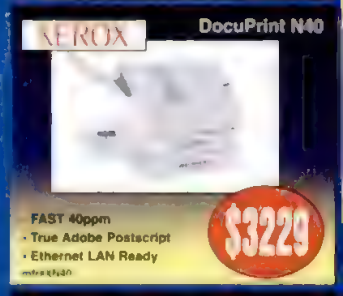

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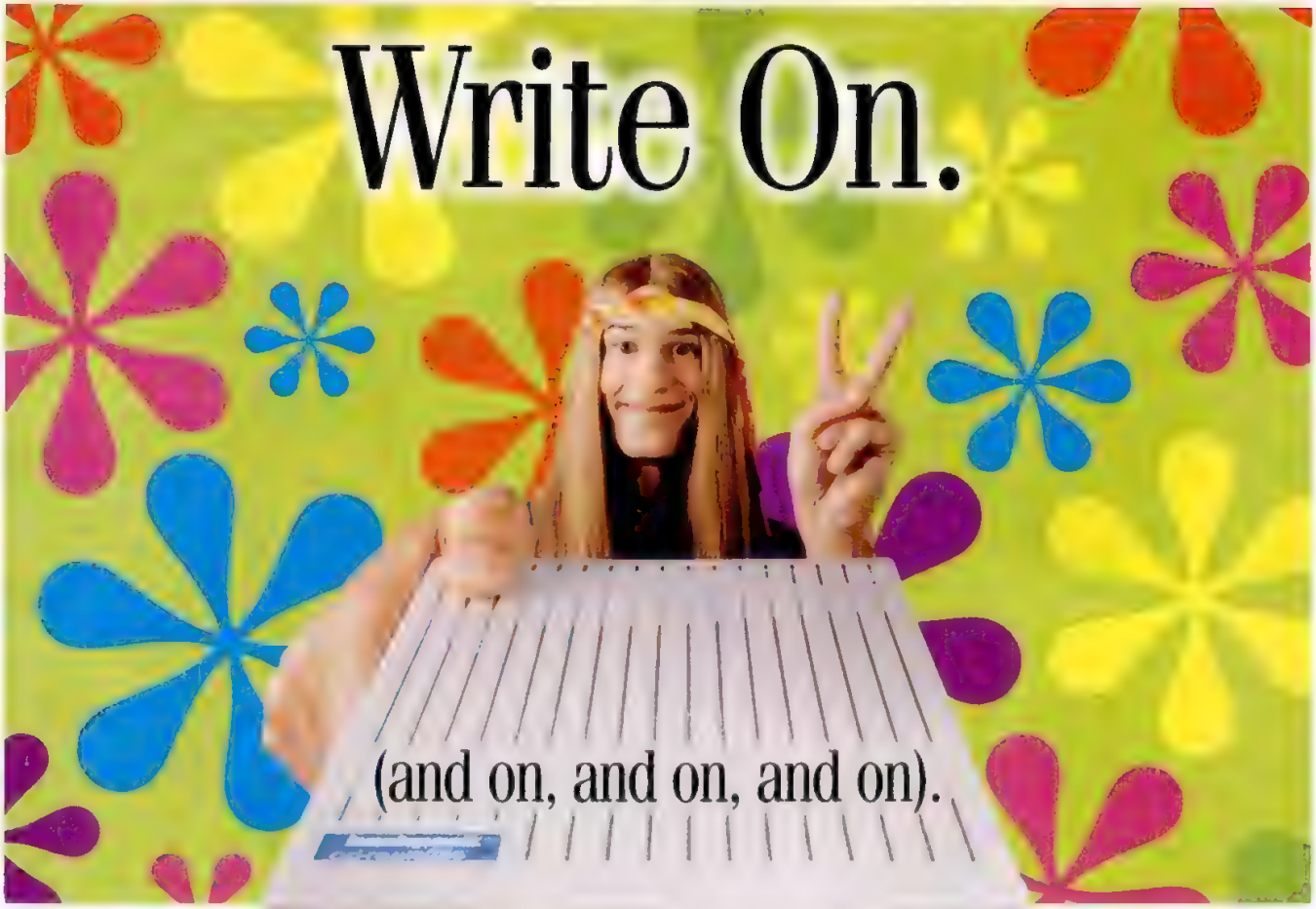

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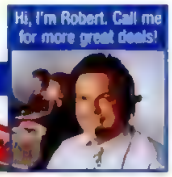

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106885 400Celeron/64MB/6.4GB/32X 1099
102357 350PII/64MB/4.3GB 1129
102358 350PII/64MB/10.0GB/32X 1449
102359 400PII/64MB/10.0GB/32X 1549
102360 450PII/64MB/10.0GB/32X 1679

COMPAQ EN Desktop

108807 400Celeron/64MB/6.4GB $1179
108808 400Celeron/64MB/6.4GB/10-100 1249
56038 350PII/32MB/6.4GB 1259
102347 400PII/32MB/6.4GB 1369
102291 350PII/64MB/10.0GB/10-100/WinNT 1599
102294 450PII/64MB/10.0GB/10-100/WinNT 1949
102348 450PII/64MB/9.1GB/32X/WinNT 2399

COMPAQ EN Minitower

102343 300ACeleron/32MB/3.2GB/32X $1029
102346 333Celeron/32MB/6.4GB/32X 1179
102288 333Celeron/32MB/6.4GB/32X/10-100 1259
56051 350PII/64MB/6.4GB/32X/WinNT 1549
102296 450PII/64MB/6.4GB/32X/10-100/WinNT 1869

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102177 333Celeron/32MB/4.3GB/32X $799
108939 366Celeron/64MB/8.0GB/32X 1099
108994 400Celeron/64MB/8.0GB/32X 1149
101971 350PII/32MB/8.0GB/32X 1199
102670 450PII/64MB/8.0GB/32X 1649

Hewlett-Packard Vectra VE8

103656 350PII/32MB/3.2GB $1049
103835 400PII/32MB/3.2GB 1259
104041 400PII/64MB/6.4GB/32X 1449
103841 450PII/64MB/6.4GB/32X/10-100 1879

Hewlett-Packard Vectra VL8

100966 350PII/64MB/4.3GB/32X $1499
108042 400PII/64MB/6.4GB/32X 1599
58873 400PII/64MB/10.1GB/32X/10-100 1749
103132 450PII/64MB/10.1GB/32X/10-100 2099
104768 450PII/64MB/10.1GB/DVD/10-100 2149

IBM

IBM PC 300GL Desktop

101983 350PII/32MB/3.2GB $1029
101985 450PII/64MB/6.4GB/32X 1599

IBM PC 300GL MiniTower

108171 350PII/32MB/8.4GB/32X/10-100T $1259
108174 400PII/64MB/8.4GB/32X/10-100T 1369
59585 400PII/64MB/6.4GB/32X 1399

IBM PC 300PL Desktop

101987 350PII/32MB/4.2GB $1269
54602 400PII/64MB/6.4GB/32X 1599

IBM PC 300PL MiniTower

54607 400PII/64MB/6.4GB/32X $1599
101993 450PII/64MB/6.4GB/32X 1839

Inteva Minitower

108023 333K6-2/32MB/4.3GB $599
108230 333MII /32MB/4.3GB/40X/56K 699
108234 333PII/32MB/4.3GB/40X/56K 799*
108028 350PII/32MB/4.3GB 799
108026 400K6-2/96MB/8.4GB/40X/56K 999
108037 350PII/64MB/8.4GB/40X/56K 999
108236 400K6-2/32MB/4.3GB/4Lx/56K ..... 999†
108026 400Celeron/64MB/8.4GB/4 x/56K 999*
108041 450PII/128MB/12.0GB/2xDVD/56K 1599

*Includes 15" monitor. †Includes 1 monitor.

UMAX

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105100 350PII/64MB/6.4GB/36X/56K/8MBAGP $999
105101 400PII/64MB/8.4GB/36X/56K/8MBAGP 1299

NOTEBOOKS

Acer

Acer Extensa

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109104 300MMX/32MB/4.1GB/20X/56K/12.1"TFT 1549
109107 300PII/64MB/6.0GB/24X/56K/14.1"TFT 2549

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COMPAQ Armada 1700 Series

103055 233PII/32MB/3.2GB/24X/56K/12.1"HPA $1799
58895 233PII/32MB/4.0GB/24X/56K/12.1"TFT ..2049
103054 300PII/32MB/5.0GB/24X/56K/14.1"TFT ..3299

COMPAQ Armada 3500 Series

103057 266PII/32MB/4.1GB/12.1"TFT $2699
103058 300PII/64MB/6.4GB/13.3"TFT 3599

COMPAQ Armada 7000 Series

55276 266PII/64MB/5.0GB/20X/13.3"TFT $3599
102985 300PII/64MB/6.4GB/24X/13.3"TFT 3895
102989 300PII/64MB/6.4GB/24X/33.6Cell/13.3"TFT 4095
102995 300PII/64MB/8.0GB/DVD/33.6Cell/14.1"TFT 4799

COMPAQ Presario

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102463 266MMX/64MB/4.0GB/24X/56K/12.1"TFT 1999*
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58296 266PII/64MB/4.0GB/24X/56K/13.3"TFT ..2799
101785 300PII/64MB/6.4GB/DVD/56K/13.3"TFT ..3499*

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102859 266PII/32MB/4.0GB/24X/56K/13.3"TFT ..2399
104626 266PII/32MB/4.0GB/56K/13.3"TFT ..2699
102861 300PII/32MB/5.0GB/24X/56K/13.3"TFT ..2899
104625 266PII/32MB/4.0GB/20X/56K/13.3"TFT ..2899

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108353 266PII/32MB/4GB/24X/56K/12.1"TFT 1799
108354 300PII/64MB/4GB/24X/56K/12.1"TFT 2099
108355 333PII/64MB/6.4GB/24X/56K/13.3"TFT 2699

IBM

IBM ThinkPad 380

101585 233PII/32MB/4GB/24X/13.3"TFT $1789
103308 233PII/32MB/4GB/13.3" TFT 1859
101586 300PII/32MB/4GB/24X/13.3"TFT 1899

IBM ThinkPad 390

104279 233MMX/32MB/3.2GB/56K/12.1"TFT $1599
104280 233PII/32MB/3.2GB/56K/12.1" TFT 1699
104283 266PII/64MB/4.3GB/56K/14.1"TFT 2249

IBM ThinkPad 560

101593 233PII/32MB/4GB/56K/12.1"TFT $1959
101594 300PII/64MB/6.4GB/56K/12.1"TFT 2399
101595 300PII/64MB/6.4GB/56K/12.1"TFT 2499

IBM ThinkPad 600

100860 233PII/32MB/3.2GB/24X/56K/12.1"TFT ..$2049
101589 300PII/64MB/5.1GB/24X/56K/13.3"TFT ...3199
101590 300PII/64MB/5.1GB/OPE 3259

IBM ThinkPad 770

101583 300PII/64MB/8.1GB/56K/DVD/14.1"TFT ..$3679
101582 300PII/128MB/8.1GB/24X/56K/WinNT/14.1 3749
101581 300PII/128MB/8.1GB/56K/14.1"TFT 3799

SHARP

Sharp Actius UltraLite

59797 233MMX/64MB/3.2GB/56K/11.3"TFT/3lbs..$1799
103002 266MMX/64MB/4.3GB/56K/11.3"TFT/3lbs 2199

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Toshiba Satellite

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103398 266PII/32MB/4.1GB/24X/56K/12.1"TFT ..1798
109332 300Celeron/64MB/4.3GB/24X/56K/13.3"TFT 1999
103446 300PII/64MB/6.4GB/24X/56K/13.3"TFT ..2399
109333 366PII/64MB/6.4GB/24X/56K/14.1"TFT ..3199

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101101 266PII/32MB/4.3GB/56K/12.1" TFT $2399
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102882 300PII/64MB/8.1GB/24X/56K/14.1" TFT ..3499
109515 366PII/64MB/8.1GB/24X/56K/13.3" TFT ..3799

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39153 PalmPilot Professional Edition 1MB $179.95
54184 Palm III 2MB, Backlit, Infared Port 289.95

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51893 Pager Watch (Ridge Face) $99
57121 Pager Watch (Five Point Face) 99

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104892 Cassiopeia E-11 ..... $396

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59627 C-Series 2015c $699

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52245 CrossPad $349.95*
102534 CrossPad XP 6" x 9" 300

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Franklin Electronics

101561 REX Pro 5 for Laptops $189.95
101562 REX Pro 5-DS for Desktops 289.95

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49958 620LX Color Palmtop PC $699
105246 Jornada 820 190MHz/16/56K/8.2"CSTN/CE 899
59973 660LX Color Palmtop PC 899

Philips

55577 Nino 301 4MB w/Dock and Battery $299.95*
58903 Nino 312 8MB w/Dock, Battery and Modem ..399.95
51843 Velo 500 16MB w/Dock 499.95
51844 Velo 500 24MB w/Dock 599.95

*with rebate.

Psion

42282 Series 5 Palmtop 8MB $449.95

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48466 Mobilon HC-4500 ..... $649.95
58197 Mobilon HC-4600 16MB 699.95
104295 Mobilon Pro PV-5000 879
104289 Tn-Pad PV-6000 999

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43320 19" Elite 751 ..... $689
105741 21" SuperScan 811 999

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107721 18.1" Flat Panel LCD TFT (White) $2949
107722 18.1" Flat Panel LCD TFT (Black) 2949

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102655 17" VisionMaster 400 ..... $419
49695 19" VisionMaster 450 599
55681 21" VisionMaster 501 899

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101805 14" VS-4D $129
105758 15" VS-55 149
108713 17" VS-7E 259

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32695 17" DX700T Technitron 329

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100825 NEW! 19" Diamond Scan 90E $659
103064 17" Diamond Plus 72 499
53318 17" Diamond Plus 100E 900
101699 21" Diamond Pro 1000E 1299

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43812 15" MultiSync A500 ..... $199
43816 15" MultiSync E500 269
100198 17" MultiSync M700 599
49696 17" P750 Mist White 669
104182 21" Multisync E1100+ 1129
101425 21" MultiSync P1250+ 1149
55433 20.1" LCD2010 (LCD) 4999

Optiquest

39386 15" Q53 ..... $179
39387 17" Q71 239
44599 21" V115 979

Philips

100838 17" 107S $349

Princeton Graphics

49278 17" Ultra 72 ..... $249
101420 19" EO900 499

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52908 15" High-Resolution LCD TFT $1499

Sony

48123 15" Multiscan 100ES $199
48755 17" Multiscan 200ES 389
48748 17" Multiscan 200PS 579
48750 21" Multiscan 500PS 1139

ViewSonic

49844 17" E771 ..... $319
49867 17" GS771 379
31254 21" G810 999
102762 21" P815 USB Monitor 1279

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106147 Xpert 128–AGP 16MB $129.95
48992 All-in-Wonder Pro–PCI 8MB 139.95*
105997 Rage Fury–AGP 32MB 179.95

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Creative Labs

105589 3D Blaster Banshee–PCI 16MB $129.95
53366 3D Blaster VooDoo2–PCI 12MB 149.95
103451 Graphics Blaster Riva TNT–AGP 16MB 169.95

Diamond

106715 Monster 3D II–PCI 12MB 159.95
101741 Viper V550–AGP 16MB 159.95
101742 Viper V550–PCI 16MB 159.95

Matrox

105995 Millenium G200–PCI 8MB $119
57623 Millenium G200–AGP 8MB 139
103516 Marvel G200 IV–AGP 8MB 279

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Brother

58743 HL-1040 Laser $298
100025 MFC 7150C Multi-Function Center 499

Canon

44669 BJC-50/80 IS-12 Color Image Scanner Cart. ..$99
43980 BJC-250 Bubble Jet Printer 129

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102810 Color MultiPass 3500 Print/Scan/Copy/FAX 299
44670 BJC-80 Portable 299
55854 BJC 50 Portable 349

Epson

109452 Stylus Color 740 ..... $249
55141 Stylus Photo 700 Photo 249
55845 Stylus Color 850 Inkjet 349
42897 Stylus Color 1520 Large Format Inkjet 499
55414 Stylus Photo EX Photo 499
104328 Stylus Color 3000 13" x 19" 7ppm 1440 x 720dpi Full-Bleed Inkjet 1299

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105068 DeskJet 420C $99
101194 DeskJet 697C 179
44246 DeskJet 722C Printer 279
102592 DeskJet 895 Cse 399
103978 LaserJet 1100se 399
53625 LaserJet 3100se Print/Scan/Copy/FAX 899
100020 LaserJet 2100 699
55464 2000Cse Professional Series Printer 799
100613 LaserJet TN 2100 999
47064 LaserJet 4000se 1149
53515 LaserJet 5000N 11" x 17" Network-ready 1999
104989 Color LaserJet 4500 2499
104954 Color LaserJet 8500 5799

Lexmark

59347 1100 Color Jetprinter $79.95*
45773 Optra E+ Laser 349
56071 Optra S 1855N Laser w/NIC 1399
56074 Optra S 2455N Laser w/NIC 2099
41264 Optra SC 1275N Color Laser w/NIC 2649

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47690 PageWorks 12 Laser Printer $489
102276 PageWorks 20 Laser 679*

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NEC

59000 SuperScript 870 Laser $349
52075 SuperScript 1260 Laser 649

Okidata

32232 ML-320 Turbo Dot Matrix $329
7952 ML 590 Dot Matrix 449
45346 OkiPage 6e LED 249

Sharp

63911 UX-2200CM 6-in-1 Multifunction Print/Scan/FAX/Copy/PC FAX/Phone $299.95
51838 UX-500 3-in-1 Plain Paper Fax 199.95

Tektronix

102731 Phaser 740L Color Capable Laser $1499
102734 Phaser 740 Color Laser Printer 1999

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60445 DocuPrint N24 Laser 2399
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60441 DocuPrint N40 Laser 3249

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Fujitsu

52843 ScanPartner 600C SCSI Flatbed w/ADF $1299

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101191 ScanJet 4100 Cse $199
108595 ScanJet 5200 Cse 299
101063 ScanJet 6200 Cse 399

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104656 Flatbed Color 169.95

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104196 SlimScan C3 USB $49.95*
57799 ScanMaker X6EL 229.95*
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40612 Dmage Scan Dual Film Scanner $699

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55077 Super CoolScan 2000 ..... $1799

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31234 SprintScan 35 Plus $1399

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101653 Astra 1220U $129*
54475 Astra 1220S Cross-Platform 149*
40085 Astra 1200S 149
51167 PowerLook II Duo/Photoshop LE 795*

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102589 PaperPort One-Touch 5300 ..... $89*
102229 PaperPort One-Touch 7600 USB 149*
40455 PaperPort Strobe Parallel 169*
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DIGITAL CAMERAS

Canon

57727 PowerShot A5 Digital Camera $499
57435 ZR MiniDV Camcorder 995
101674 Vistura MiniDV Camcorder 1295
57434 Optura MiniDV Digital Camcorder 1595
108982 XL1 MiniDV Camcorder 4495

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56897 DC220 ..... $999
56896 DC260 899

Olympus

55672 D-340L $499
104248 D-400 Zoom 799
47234 D-600L 899
104249 D-620L 1199

SONY

107238 NEW! DSC-D700 ..... $1899
103305 Mavica FD81 799
105337 Mavica FD91 999

Toshiba

100907 PDR-M1 ..... $495

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Epson

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InFocus

101433 LP425 LCD Projector $3499
101445 LP735 LCD Projector 6999

Polaroid

49917 Polaview 215 LCD Projector $3199
52858 Polaview 211E LCD Projector 3499

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106778 Eagle Touch Keyboard PS/2, Win98 ..... $12.95
54451 Powermouse Ergonomic PS/2 ..... 14.95
30217 Nu-Form Split-Key Keyboard PC 29.95
30219 Nu-Form Split-Key Keyboard w/TouchPad PC 44.95
21345 TruForm Extended Keyboard PC 44.95

Belkin

58906 USB 3 Button Mouse $19.95
58904 USB 104 Key, Keyboard 39.95
49333 USB Express Hub 69.95

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101529 Televisor T3 Pro PC TV Converter $299.95

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57085 Mouse in a Box Scroll PC $24.95
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39535 Orbit Trackball PC 49.95
25095 Expert Mouse 99.95

Keytronic Corporation

39590 104 Keyboard PS2 ..... $24.95
40987 Keytronic Classic Keyboard 29.95
57099 Lifetime Mouse PS/2 ..... 39.95

Logitech Inc.

45843 First Mouse PS/2 ..... $16.95
102961 MouseMan Wheel Mouse 49.95
49720 Trackman Marble FX 79.95
102951 Cordless Desktop Keyboard and Mouse 99.95

Wacom

101872 Intuos 6" x 8" $289.95

MULTIMEDIA

Creative Labs

106053 Blaster 48X CD-ROM Drive $79.95
53366 3D Blaster VooDoo2 128MB PCI 149.95
100142 Sound Blaster 128 plus 4-Pc. Speakers 149.95
100196 Sound Blaster Live! 195.95
103447 PC-DVD Encore 5X DVD-ROM Kit 249.95

DATA STORAGE

Hewlett Packard

101297 CD-R Media 50-Pack $89.95
105848 8GB Colorado Internal Tape Drive w/Tape 259
105042 8GB Colorado External Tape Drive w/Tape 299
100153 Surestore 8110i CD-Writer Plus External 399
105632 24GB Surestore Dat 24i DDS-3 Internal 1099

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103688 NEW! Clik! Drive Plus 40MB $299.95
104268 NEW! Zip Drive USB 149.95
102878 Jaz 2GB SCSI External 349.95
107817 Zip 250MB Parallel 199.95
106303 Jaz Drive 1GB SCSI External (Refurbished) 199.95
102641 Zip Drive Parallel External 119.95
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46890 Zip Drive ATAPI Insider 99.95
103933 Zip Disk 10-Pack (Gray) 99.95
32556 Jaz 1GB Disk 3-Pack 269.95
47079 Jaz 2GB Disk 3-Pack 399.95

Kodak

101649 CDR Media-30 ..... $59.95

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52498 CDR 74min 10-Pack $19.95
48599 CD-RW Disc 5-Pack w/5 FREE CD-R Discs 49.95
39020 CDR 74min 100-Pack 149.95

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Quantum

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50868 6.4GB Fireball SE Ultra SCSI HD 389
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51474 8.6GB Medalist Ultra ATA HD 199
50294 8GB TapeStor Int. SCSI Travan Tape Drive 219
54435 9.1GB Medalist Pro Ultra ATA HD 239
54282 9.1GB Barracuda 9LP Ultra Wide SCSI 439
55983 9.1GB Cheetah Ultra2 LVD HD 689
56519 18.2GB Barracuda Ultra Wide SCSI HD 839
56524 18.2GB Cheetah Ultra2/LVD HD 1299

Smart and Friendly

103196 2x2x24 CD Racer $319.95
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16559 Back-UPS 280 (180 Watts) $59.95
56165 Back-UPS Office 280 ..... 84.95
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56167 Back-UPS 500 (330W) 149.95
56169 Back-UPS Pro 420 (260W) 229.95
56170 Back-UPS Pro 650 (410W) 279.95
31466 Smart-UPS 700 Net (450W) 369.95
21929 Back-UPS Pro 1000 (670W) 379.95
31469 Smart-UPS 1400 NET (950W) 629.95
31470 Smart-UPS 2200 NET (1600W) PowerChute+ 899.95

Opti-ups

101381 280ES (280W) $99
101383 420ES (420W) 149

Tripp Lite

101100 Super 6 + Tel $15.95
21831 Super 7 Surge Suppressor 17.95
6786 Isobar 4 Ultra 44.95
29274 BC Internet 325 VA (After mfr's $25 rebate) 49.95
8630 Isobar 6 Ultra 54.95
13147 Isotel 6 Ultra 64.95
21944 BC Pro 1400 UPS (940 Watts) 419.95
45091 SmartPro 1400 NET UPS 494.95

NETWORKING

3Com

53094 3Com/USR External faxmodem $149.95
55204 Fast Etherlink XL with Wake Up 5-pack 399.95
51639 SuperStack II Dual Speed Hub 500 24-Port 949
53751 SuperStack II Switch 3300 24-Port 2149

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38297 10BaseT FriendlyNet 8-Port Hub $49.95
107652 FriendlyNet 10/100 8-Port Hub 179.95
100983 FriendlyNet 10/100 8-Port Switch 399.95

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103180 Baystack 350-24T 24-Port Switch $1799

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104812 OmniCube 2-Port KVM Switch $99.95
104813 OmniCube 4-Port KVM Switch 119.95

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52027 Catalyst 2924XL 24-Port Switch $999

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107126 10/100BaseT 5-Port Switched Hub $84.95
59457 10/100BaseT 8-Port Switched Hub 189.95

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29562 Jet Direct EX Plus Print Server Ethernet LANs $229.95
53458 JetDirect 300X 10/100 Print Server 229
100538 ProCurve 24-Port 108T Hub 179*
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103647 Create & Share Camera w/Software & Bunny Doll 99.95*
104535 Netport Express 3-Port Print Server 329.95
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44783 10BaseT 5-Port Workgroup Hub 42.95
59208 10/100BaseTX 8-Port Auto-Sensing Hub 149.95
59206 StackPro II 16-Port 10/100 Hub 459.95
102706 EtherFast 10/100 24-Port Switch w/ FREE 10-Pack LAN Cards 979.95

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35484 FA310TX 10/100BTX Fast Ethernet PCI Adapt. $24.95
107699 SW108 8-Port Switch w/2 FREE NIC Cards 189.95
107697 RT328 ISDN Router w/ FREE 6-Port Hub 289.95
108116 Fast Ethernet 8-Port Switch 529.95
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108216 DS524 10/100 24-Port Hub w/6 FREE NIC Cards 684.95

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102700 Realport Ethernet 10/100 ..... $144.95
55424 RealPort 56K Modm & 10/100BTX Enet Adapt. 319.99

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54674 Adobe Photoshop 5.0 Version Upgrade $189.95
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108878 Adobe Illustrator 8 Upgrade 118.95
108160 Adobe Illustrator 8 ..... 359.95
43823 Adobe Acrobat 3.0.1 ..... 189.95
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32845 Adobe PageMaker 6.5 ..... 549.95
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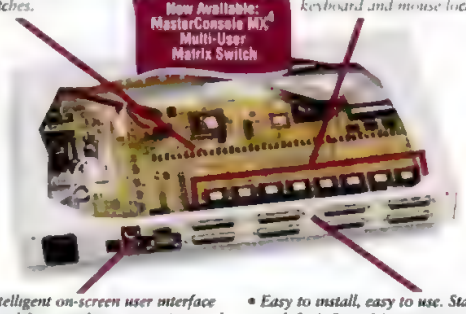

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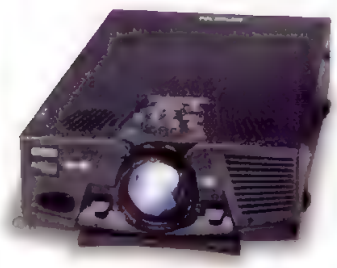

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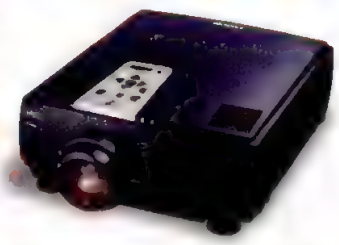

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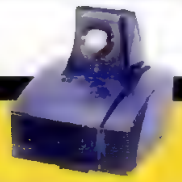

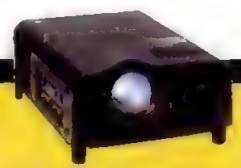

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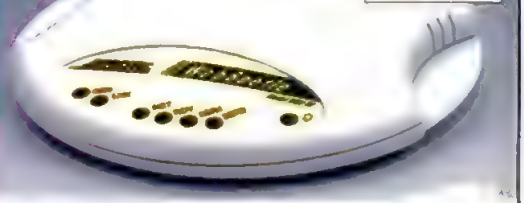

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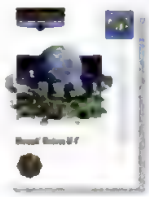

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Hint #3: It uses chips instead of rotating cylinders.

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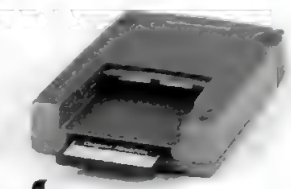

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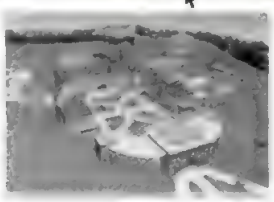

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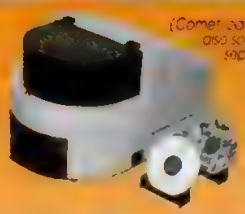

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INTERNET GAMING

Online Action

By Michael E. Ryan

Though it used to be an arcane practice open to only the most hard-core computer game fanatics, online gaming is rapidly becoming one of the most popular activities on the Internet. But knowing where to go and how to get started can still be confusing—which is where online gaming services come into play. These ever-expanding services provide a ready-made online social environment, where players can meet and greet their peers, set up and join gaming sessions, and (most important) pound their newfound friends into the virtual dirt in their favorite games.

This year, we look at six online gaming services: GameStorm, Heat.net, Kali, Microsoft Gaming Zone, Mplayer.com, and Total Entertainment Network (TEN). We evaluated each for performance, price, availability and types of games, and ease of use. Another service, GameHub (www.gamehub.com), went online just as this story went to press, so we were unable to include it in this roundup. In the end, Kali and Mplayer.com walked away with our Editors' Choice awards.

GameStorm

Kesmai Corp.'s GameStorm is unique among the services we reviewed. Instead of being a matchmaking service for players of popular retail computer games, GameStorm specializes in proprietary, online-only games for large numbers of players.

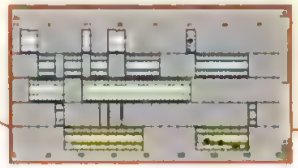
At $9.95 per month, GameStorm costs more than most of the other services. In fact, it is the only one to mandate a monthly subscription fee. Still, you get a lot of unique content for your money: The service provides quality games in every category imaginable. Many of the games on GameStorm are massively multiplayer, meaning that hundreds and even thousands of players can simultaneously participate in the game world. The Air Warrior titles (three World War II era flight simulations) continue to be the service's most popular games. Simpler games such as Casino Poker are also extremely popular. Both cooperative and death-match-style games are available through the service.

Players access GameStorm via their Web browsers, and the interface is basically simple HTML. Performance is generally consistent, but you should still expect occasional lags and lapses. Warping (rapid, drastic changes in other players' positions) is common in fast-paced games like Aliens Online, so you'll want a speedy and reliable Internet connection to experience this service at its best.

In view of the monthly fee, GameStorm is probably not a great choice for the casual gamer who wants to jump online only a few times per month. You can find free classic card and board games at Microsoft Gaming Zone and Mplayer.com, after all. But for hard-core game players looking for something new that they just can't find elsewhere, GameStorm is quite a deal.

MUSIC MAKER

From hobbyist to pro, composing hits has never been easier than with Sonic Foundry's Acid. *Page 296.*



QUICK CLIPS

Go hunting, practice your pinball wizardry, create a teen fashion magazine, or rule an empire. It's all in our quick look at what's new. *Page 298.*

ILLUSTRATION BY LORA MORGENSTERN

Internet Gaming Services

SERVICE	PRICING	POPULAR GAMES OFFERED
GameStorm Kesmai Corp., *www.gamestorm.com*	$9.95 per month	Air Warrior III, Casino Poker, Legends of Kesmai, Multiplayer Battletech, Rolemaster MageStorm
Heat.net SegaSoft Networks, *www.heat.net*	Premium membership, $4.95 per month	Duke Nukem 3D, Quake, Quake II, Sin, Warcraft 2
EDITORS' CHOICE **Kali** Kali Inc., *www.kali.net*	Free demo; $20 registration	Descent 2, Duke Nukem 3D, Quake II, Starcraft Warcraft 2
Microsoft Gaming Zone Microsoft Corp., *www.zone.com*	Most games free, each premium game, $9.95 per month	Age of Empires, Backgammon, Cribbage, Hearts, Spades
EDITORS' CHOICE **Mplayer.com** Mpath Interactive Inc., *www.mplayer.com*	Premium membership, $3.95 per month	Hearts, Poker, Quake, Rainbow 6, Spades
Total Entertainment Network Total Entertainment Network, *www.ten.net*	Premium membership, $19.95 per month	Hearts, Magic: The Gathering NASCAR Racing 2, Spades, Total Annihilation

All services reviewed offer action/arcade, adventure, strategy/war, simulation/sci-fi, and sports games
All services reviewed except Heat.net and Total Entertainment Network also offer classics/family games

Heat.net

Last year, Heat.net impressed us with its wide variety of action games and its support for numerous players in a single game. This time around, those aspects of the service remain intact. Unfortunately, the problem areas—a poor interface and slow performance—are still apparent as well.

Basic membership is free, though for $4.95 per month you can sign up for a premium membership, which lets you access tournaments, rankings, and other perks. The game selection on Heat.net is excellent though tailored for action fans; games like Quake II and Sin are among the most popular.

Like GameStorm, Heat.net is an HTML-based service, so you access it through your Web browser. That is, you can access it through *some* Web browsers: We ran into problems logging on with Microsoft Internet Explorer 4.10, Netscape Communicator 4.08 (both of which include 128-bit encryption), and the beta version of Internet Explorer 5. Our best results were with the 40-bit standard-encryption version of Netscape Communicator. Once we logged on successfully, we ran into more performance problems than we saw on any of the other services.

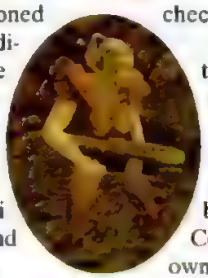
If you're into action games and you can handle the performance and compatibility issues, you may want to take a look at Heat.net, but your best bet is to avail yourself only of the free-membership option.

Kali

PC MAGAZINE EDITORS' CHOICE

Kali is simply a marvel of software engineering. Beginning life as a rough utility that let college students play Interplay's Descent over the Internet, Kali has evolved into a full-featured, fast, and reliable gaming system.

Though Kali is not your average online gaming service, it is so popular (with over 250,000 registered users) and so useful that we feel it must be mentioned alongside the more traditional ones. In its free demo mode, Kali allows 15-minute gaming sessions before timing out. For a one-time $20 registration fee, however, Kali supports unlimited use (and unlimited free upgrades).



Kali is purely a matchmaking service, so players use the software to find other players with similar tastes in games and good connections to the Net (reported via ping times). This service works with any multiplayer game supporting IPX, as well as a number of titles that use TCP/IP.

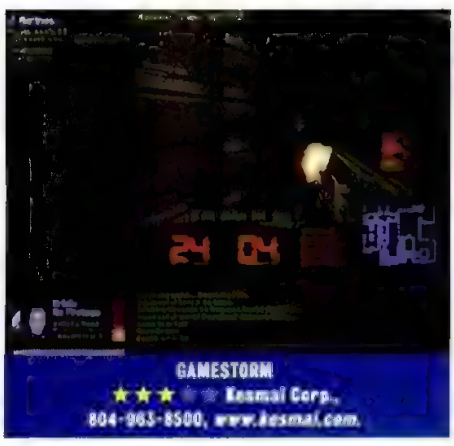
Kali is not as pretty or intuitive as the other services in this roundup, but it seems to grow more user-friendly with every version (and it's constantly being updated). Game performance is excellent, as long as you find other players with low ping times. The software even includes its own proxy server, so you can connect multiple PCs on a LAN to an Internet game using only one dial-up connection.

Kali takes a little getting used to, yet it offers great performance and the widest possible support for games and game types.

Microsoft Gaming Zone

The well-rounded Microsoft Gaming Zone has something to offer almost all types of game players, whether they are into checkers or air combat. The Zone, as it's typically called, is free for the bulk of the games it supports. Certain premium games, such as CyberStrike 2 and UltraCorps, each carry their own monthly subscription fee (usually $9.95).

Thankfully, the browser-



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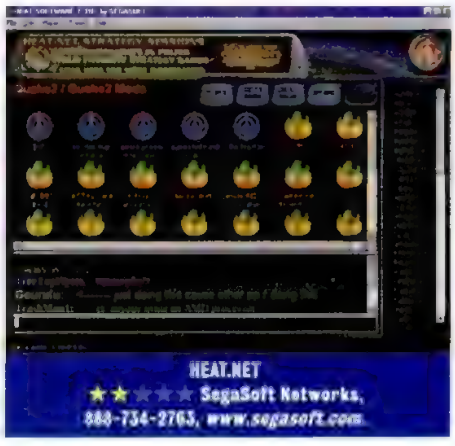

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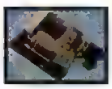

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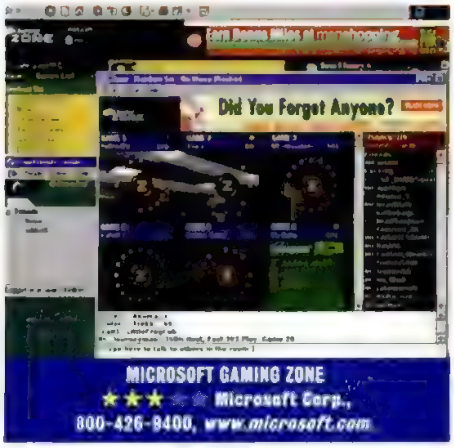

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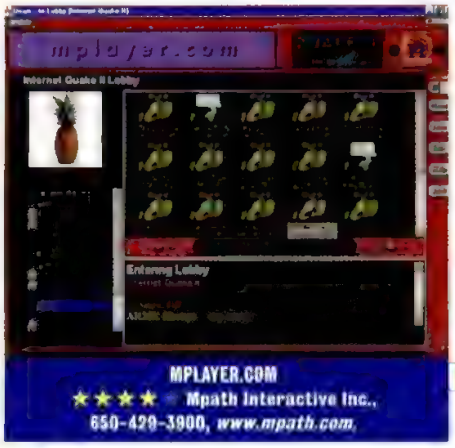

MPLAYER.COM
★★★★ Mpath Interactive Inc.,
650-429-3900, *www.mpath.com*

TOTAL ENTERTAINMENT NETWORK
★★★ Total Entertainment Network,
800-804-0836, *www.ten.net*

based service is now accessible from both Microsoft Internet Explorer and Netscape Navigator, but the interface is clunky no matter which browser you use. You still run into far too many overlapping windows on the Zone, and there is simply too much clutter on the screen when you enter a game's chat room.

Still, the variety of games on the Zone is outstanding. You'll find a lot more than just Microsoft titles here. Every night, thousands of casual players log on just to play card games and other classics, while retail games such as Age of Empires and Tom Clancy's Rainbow Six draw large crowds of hard-core game players.

Performance is usually pretty good on the Zone, but we did run into occasional lag problems with some of the more popular (in other words, more crowded) games. If Microsoft could just clean up the unsightly interface, Microsoft Gaming Zone would challenge Mplayer.com for the online gaming crown.

Mplayer.com

PC MAGAZINE EDITORS' CHOICE

Mpath Interactive's Mplayer.com is the most impressive gaming service we saw this year. It offers an excellent selection of games, a great price for premium membership, a slick interface, and solid performance.

Basic membership is free on Mplayer.com, and the premium membership costs only $3.95 per month. With it, you gain access to player rankings, tournaments, and a variety of other goodies. Even if you don't opt for this package, however, you'll have access to a vast array of gaming opportunities with the basic membership.

You access the service through your Web browser, entering a separate Mplayer.com front end when you set foot in a game's chat room or matchmaking screen. We really liked the service's updated, sleek interface. And although we weren't thrilled with the number of online advertisements, we did appreciate the way they were smoothly integrated into the service.

Mplayer.com offers a wide variety of games in every major gaming category (including classics such as chess and card games such as spades). Performance is quite good, and there is never a shortage of players here. The maturity level in the chat rooms is occasionally disappointing, but for the most part, gaming via Mplayer.com is an enjoyable experience. One of our favorite features is the service's automatic update system, which downloads and installs updates for the client software, as well as for the games.

At the moment, Mplayer.com is the service to beat in the online gaming community.

Tools of the Trade

If you want to become a serious online game player, you had better make sure you've got the right equipment. Without it, you'll be left wondering what all the hype is about. Here's a brief list of the five key ingredients for an enjoyable online gaming experience.

- **A fast PC.** Don't get us wrong, you don't need to have a multiprocessing monster on your desktop, but for top-notch performance you should have an Intel Pentium II or AMD K6-2 machine with at least 64MB of RAM, a 24X CD-ROM drive or faster, and a hard disk of at least 8GB. It'll make all the difference in the world as you're chasing down your enemies and doing battle with the bad guys.
- **A killer 3-D card.** Although some online games get along fine without 3-D acceleration, you'll find that most of the popular action games look and run a whole lot better when you have a powerful 3-D card. Currently, the cards to look for contain the 3Dfx Voodoo2 or nVidia RIVA TNT graphics chip set.
- **A fast modem *and* a good ISP.** On the modem side, you shouldn't even consider most current online games unless you have at least a 56K modem (of course, games in which time isn't of the essence, such as spades or backgammon, are an exception). But don't neglect your choice of ISP; it's just as crucial to a smooth, enjoyable online gaming experience. If you have trouble connecting to your provider or experience frequent time-outs and disconnects, you will not have a lot of fun playing games over its network.
- **ICQ.** A handy little shareware utility from America Online–owned Mirabilis (*www.mirabilis.com*), ICQ—shorthand for "I seek you"—is a real-time Internet paging and chat program, which lets you keep in touch with all of your online pals (game players or not). It's extremely useful for coordinating an online game with your friends, and for sending and receiving important game-related files and information.
- **GameSpy 3D.** A must-have for action-gaming fans, this shareware utility from Critical Mass Systems helps you locate and join online sessions of the most popular action titles (*www.gamespy.com*). Currently, GameSpy 3D supports Hexen II, Quake II, Shogo: Mobile Armor Division, Sin, and Unreal, with more games being added to the list all the time.—*MR*

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Total Entertainment Network

Last year's most impressive online gaming service is pretty much its same old self this time around. But that's not necessarily a good thing when the competition is moving forward. Total Entertainment Network (TEN) remains a fast, reliable service for serious game players, but its appeal for casual gamers is almost nil.

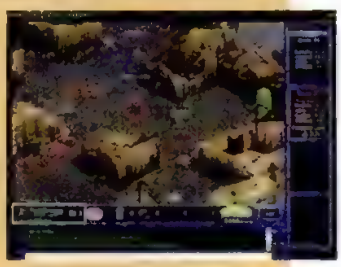
As always, TEN utilizes its own nicely designed client software rather than a Web browser. Though we like the client's basic look and feel, we cannot understand why it remains fixed at a resolution of 640 by 480 dots per inch.

Basic membership on TEN is free, but access to some of the service's higher-profile games requires a premium membership, which costs a whopping $19.95 per month. Considering the costs associated with the other services reviewed here, we just don't see this as a realistic fee. Hard-core game players may opt for premium membership to enjoy Total Entertainment Network's excellent performance (which is still the best and most consistent of the bunch). Casual game players, on the other hand, will likely have no interest in such an exorbitant fee.

In a nutshell, TEN seems to be rapidly sliding into a niche market: hard-core game players with deep pockets. If you fall into that category, TEN may be the service for you. Otherwise, look into Kali, Microsoft Gaming Zone, and Mplayer.com first.

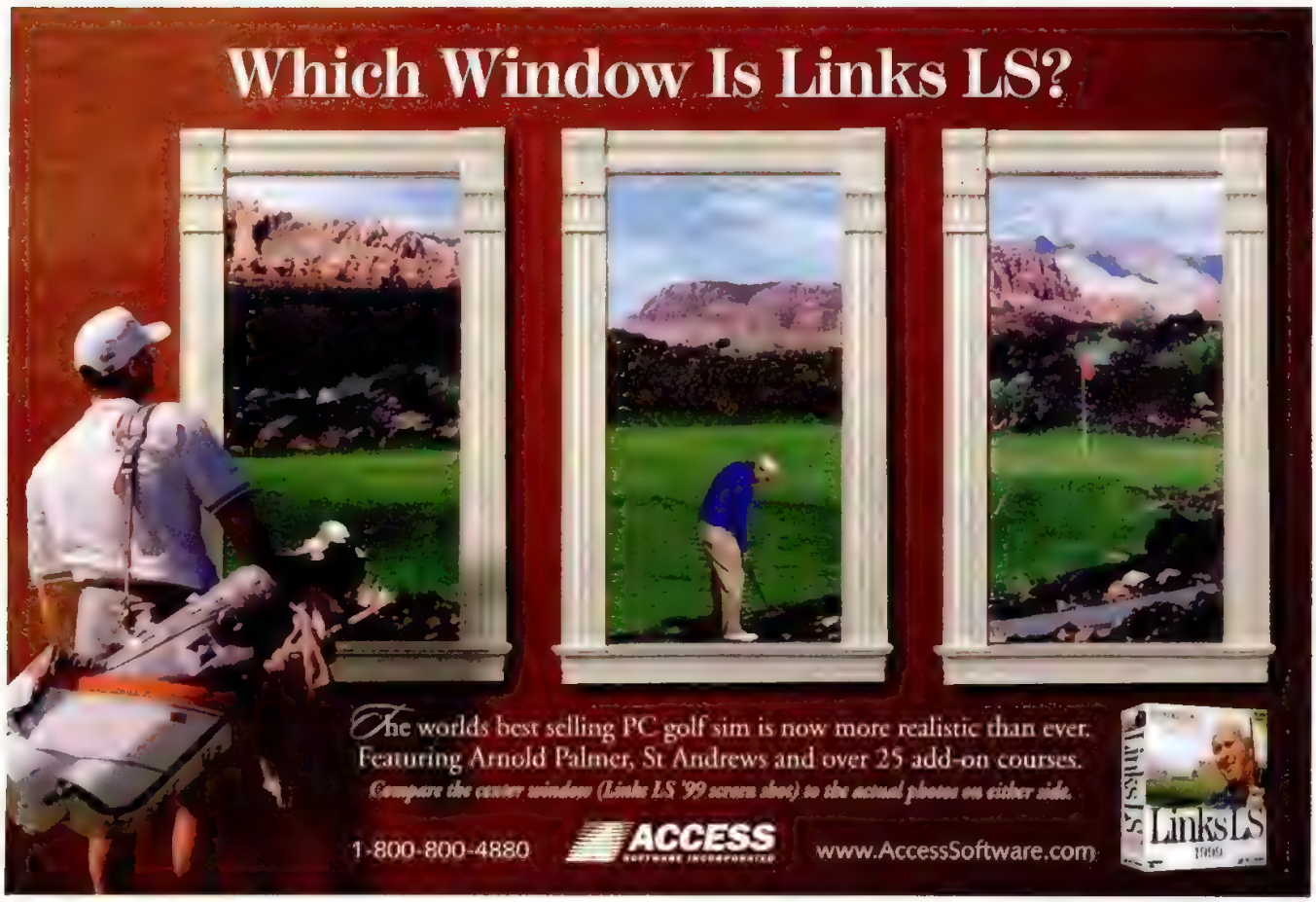
FireTeam

Looking for the next big thing in online gaming? Look no further than FireTeam (Multitude Inc., 888-689-8326, *www.fireteam.com*). This revolutionary online-only game involves team combat between groups of two to four players. To win, teams must coordinate their moves and attacks—a refreshing change from the usual anarchy of death matches.



FireTeam supports real-time voice communication between players and actually ships with a headset that lets players talk to one another during the game (so when you see a bad guy sneaking up on your buddy, you can tell him about it). Each game session is only 10 minutes, so you never have to wait around very long for some action. Also, the game is remarkably easy to learn—though pretty tough to master.

Basically, FireTeam is a blast to play and one of the best online-only games we've seen to date. As we went to press, a special edition of the game was available directly from Multitude for $59.95. This package includes the software, the headset, and unlimited online play. A separate retail package will be available later in the year, but its price has not yet been set.



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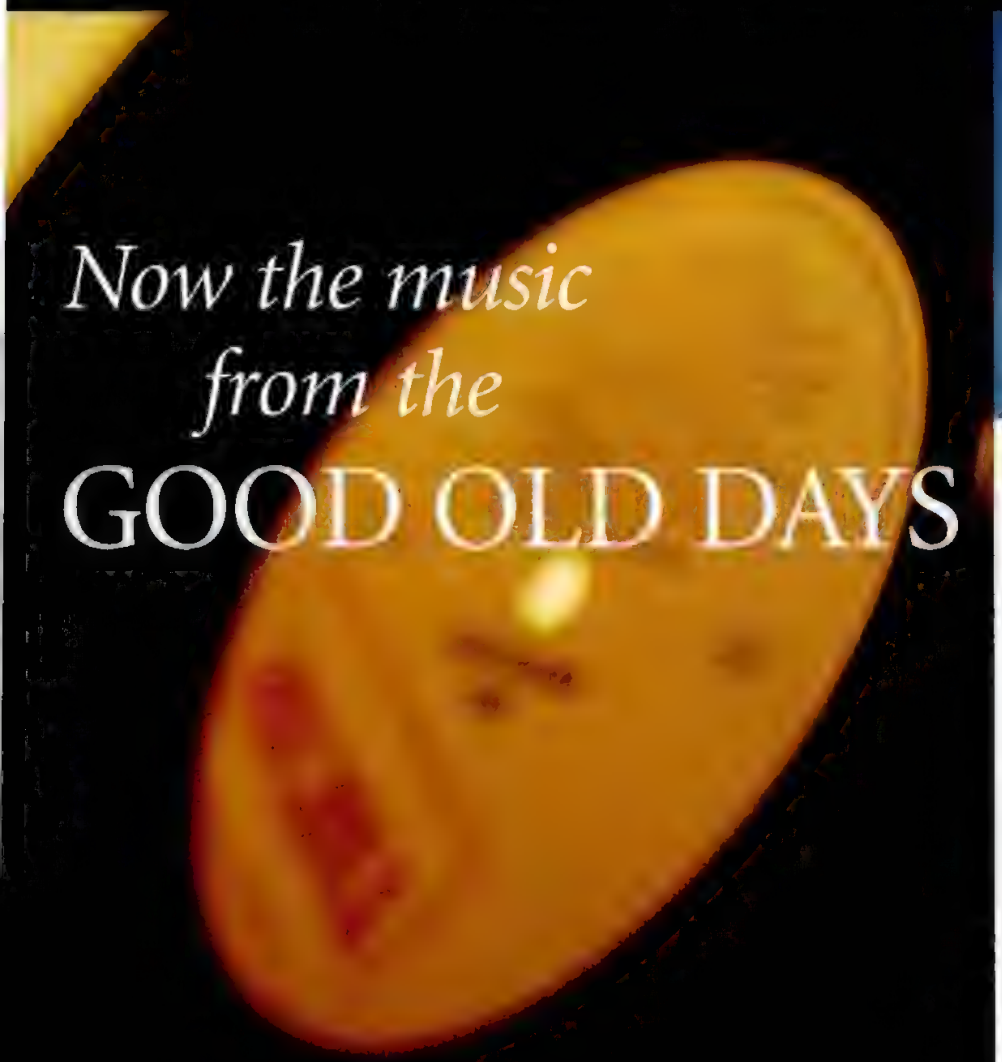

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MUSIC

Acid Rock

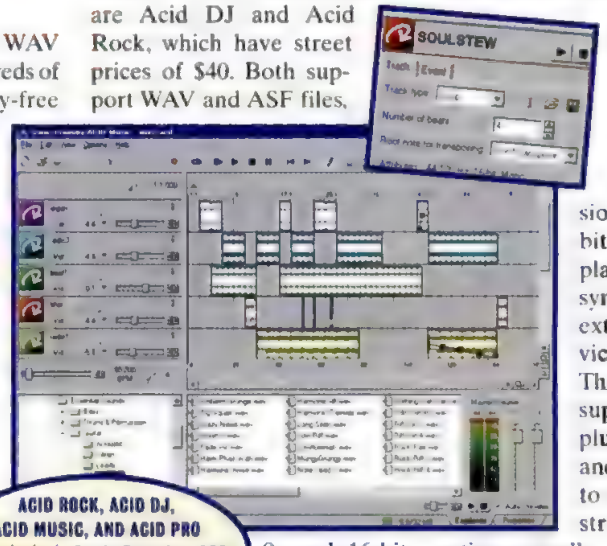
By Matthew Graven

Musical training was once an inevitable part of composing music, and multitrack studios were an expensive commodity. But home computers have made music creation a reality for almost any music enthusiast. And Sonic Foundry's Acid products are so innovative they'll change the way people compose music.

Acid's method: You build songs without playing instruments. Instead, Acid is based on loops—short, repetitive snippets of music. Each generally about a measure long, these loops consist of drums, basses, guitars, keyboards, or almost any noise you can capture digitally. The program automatically matches tempos between loops, making it easy to piece them from various sources into one composition.

You can use your own WAV files or choose from hundreds of Sonic Foundry's royalty-free loops. Acid offers an Explorer-like window for browsing through samples, and the program lets you preview each loop easily. Once you choose a loop, just drag it into the working area and Acid will add a track for that particular sample. You can even record vocals directly to an available track.

What's truly amazing about Acid is that pitch and tempo remain independent of one another, meaning you can speed up the tempo without affecting the pitch, or change a track's key without changing its tempo.



ACID ROCK, ACID DJ, ACID MUSIC, AND ACID PRO
★★★★★ Sonic Foundry, 800-577-6642, www.sonicfoundry.com.

Acid is available in three versions. The two least expensive are Acid DJ and Acid Rock, which have street prices of $40. Both support WAV and ASF files, 8- and 16-bit sample rates, and eight individual tracks.

Acid Music ($80) adds support for unlimited tracks as well as Sonic Foundry Express FX special effects. It can also draw in automated changes to a loop's pan and volume level.

For the professional, there is Acid Pro ($290). The Pro version supports 24-bit record and playback and can synchronize to an external Midi device or program. This version also supports DirectX plug-in effects and allows you to adjust a loop's stretching properties manually.

Whether you simply want to dabble in music or are an accomplished musician looking for a new way to mix tracks, Acid is sure to please.

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AFTER HOURS

Quick Clips

Deer Hunter Avenger

Penned by "Late Night with Conan O'Brien" writer Brian McCann, this parody of the popular hunting titles is good for a barrel of laughs.

As Bambo the avenging buck, you track down and bag hunters. In the words of the game, "Hasta la vista, venison-eaters." $19.95 list; Simon & Schuster Interactive, 800-542-4240, *www.ssinteractive.com.*

Glover

You play a puffy white glove trying to locate the missing crystals in this colorful, eye-catching game. The game play is very been-there, done-that, but kids and beginning gamers might want to try Glover on for size. $19.95 list; Hasbro Interactive, 800-400-1352, *www.hasbrointeractive.com.*

Reah: Face the Unknown

On first introduction, the world of Reah: Face the Unknown looks almost exactly like Riven. Unfortunately, game play doesn't adhere to Riven's high standards. The thin plot line (you are transported to an alien world and must find your way back), illogical puzzles, and unintuitive interface make this game worth overlooking. $39.99 list; Project 2 Interactive/GT Interactive, 800-610-4847, *www.gtgames.com.*

The Settlers III

Fans of this series of empire-building sagas will be pleased with the addition of three new campaigns, where your goal is to develop the economies of the Romans, Egyptians, or Asians. Newcomers to the series might be put off by the campaigns' repetition and the somewhat clunky interface. $39.99 list; Blue Byte Software, 800-933-2983, *www.bluebyte.com.*

Teen Digital Diva

Using Teen Digital Diva, teenage and preteen girls get the chance to create their own fashion magazine—complete with beauty tips, fashion makeovers, horoscopes, and the ever-popular quizzes. With a funky, hip-hop–inspired style, this disk (based on *Teen* magazine) will soon become a favorite. $36.95 list; Activision, 310-255-2000, *www.activision.com.*

3D Ultra NASCAR Pinball

In theory, this title sounds like a good time: You play as one of four NASCAR drivers and attempt to master three pinball tables inspired by stockcar racing, while trying to rack up points and win the race. But the three tables soon prove boring, and the ever-present ad banners (Kellogg's Corn Flakes, McDonald's, and so on) are obnoxious. $29.99 list; Sierra Attractions, 800-757-7707, *www.sierra.com.*

Coming Up

What's in the Next Issue of *PC Magazine*

Pentium III Desktops

Hot out of the PC Magazine Labs: We will present the first test results for Intel's new processor, the long-awaited Pentium III. We'll test seven of the first Pentium III desktops with our traditional benchmark tests and some specific tests designed to highlight the performance advantages provided by the chip's new multimedia extensions.

Fire Your Broker!

The Internet has had a roiling effect on the stock market, while the Web has emerged as a democratizing medium for picking, trading, and monitoring investments. To help you empower yourself in this new era, we'll test online brokerages, portfolio trackers, tools for picking stock and mutual funds, sources of financial news, chat sites, and more.

Free Software

Open-source software has garnered renewed attention this year. In our first comprehensive look at this phenomenon, we'll explain how the open-source model works, examine some of the biggest open-source projects (such as Apache, Linux, and Netscape's Mozilla.org), and examine the potential consequences for the software you use every day.

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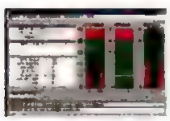

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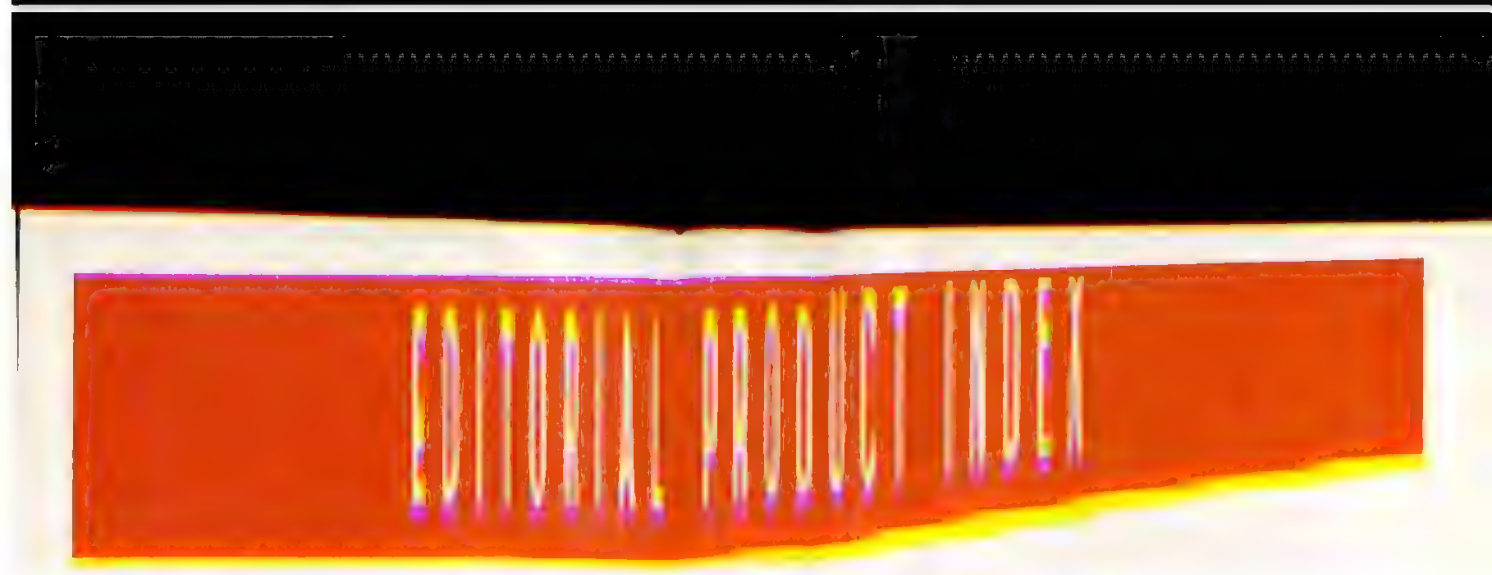

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AMD K6-2	350MHz	128MB	10.2GB	$1059.99	(CTLTM35)
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AMD K6-2	400MHz	128MB	10.2GB	$1129.99	(CTLTM37)
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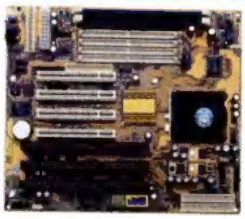

Motherboard & Case: Motherboard mounted in dual-cooling fan case; 200 Watt power supply, cable & manual. Sound and video.

Pre-Assembled Kits: Motherboard in dual-cooling fan case; 200 Watt power supply, keyboard, speakers, mouse, 56KFlex fax/ modem, 1.44MB floppy drive, 24X CD-ROM. Sound and video on board.

Tiger 571 Motherboard Features At-A-Glance

Form Factor: **Baby AT** | On Board Video: **4MB** | ISA Slots: **3**
Processor: **Socket 7** | On Board Audio: **YES** | Memory: **DIMM or SIMM**
Bus Speed: **Up to 83MHz** | PCI Slots: **4** | Max Memory: **384 MB**

Tiger 6KE LX, 6BE+ BX AGP Slot 1

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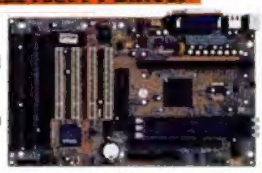


Motherboard & Case: Motherboard cables & manual

Motherboard & Case: ready to assemble! Includes motherboard in dual-cooling fan case; 235 Watt power supply, cables & manual

Tiger 6KE LX Motherboard Features At-A-Glance

Form Factor: **ATX** • CPU: **Slot 1** • Bus Speed: **Up to 66 MHz** • PCI Slots: **4** • ISA Slots: **3** • Memory: **3 DIMM Sockets** • Max Memory: **384 MB**

Tiger 6BE+ BX Motherboard Features At-A-Glance

Form Factor: **ATX** • CPU: **Slot 1** • Bus Speed: **Up to 100MHz** • PCI Slots: **4** • ISA Slots: **3** • Memory: **3 DIMM Sockets** • Max Memory: **768 MB**

Tiger S7-MVP3 ATX Super Socket 7

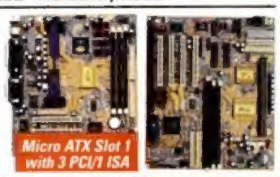
Motherboard & Case: Motherboard mounted in dual-cooling fan ATX case; 235-watt power supply, cables, manual

Pre-Assembled Kits: Motherboard in dual-cooling fan ATX case; 235Watt power supply, keyboard, speakers, mouse, 64-bit video, 56KFlex faxmodem, 1.44MB floppy drive, 24X CD-ROM, Wave Table sound.

Tiger 6KE LX Motherboard Features At-A-Glance

Form Factor: **ATX** • CPU: **Socket 7** • Bus Speed: **Up to 100 MHz** • AGP Slots: **1** • PCI Slots: **5** • ISA Slots: **2** • Memory: **3 DIMM Sockets** • Max Memory: **384 MB**

Tiger 767 AT, 760 ATX Slot 1



Motherboard & Case: Motherboard mounted in dual-cooling fan case; cables & manual

Pre-Assembled Kits: Motherboard in dual-cooling fan case; keyboard, speakers, mouse, 3D AGP video, 56KFlex faxmodem, 1.44MB floppy drive, 24X CD-ROM, Wave Table sound.

AT Slot 1 with 4 PCI/1 ISA

Tiger 767 Form Factor: **AT** • CPU: **Slot 1** • Bus Speed: **Up to 100 MHz** • On Board Video: **8MB AGP** • On Board Audio: **YES** • PCI Slots: **4** • ISA Slots: **1** • Memory: **DIMM** • Max Memory: **768 MB**

Tiger 760 Form Factor: **Micro AT X** • CPU: **Slot 1** • Bus Speed: **Up to 100MHz** • On Board Video: **8MB AGP** • On Board Audio: **YES** • PCI Slots: **3** • ISA Slots: **1** • Memory: **DIMM** • Max Memory: **768 MB**

Motherboard Design	Processors Supported	MOTHERBOARD ONLY Item No.	1-2 units	3+ units	MOTHERBOARD & CASE Item No.	1-2 units	3+ units	PRE-ASSEMBLED KITS Item No.	1-2 units	3+ units
Tiger 571 AT including Wave Table sound and PCI video	**AMD** Up to K6-300 & K62-266 **Intel** Pentium up to 233 MMX **IBM/Cyrix** Up to PR300	MB1-C-1B	$77.99	$69.99	BB1-C-1B Mid-tower AT case with 200-Watt power supply	$124.99	$114.99	KT1-C-1B	$219.99	$202.99
Tiger S7-MVP3 ATX Super Socket 7 1MB cache	All **AMD** Up to K62-4006; **Intel** Pentium up to 233 MMX **IBM/Cyrix** up to MII 350	MB1-C-2B	$57.99	$49.99	BB1-C-2B ATX case with 235-Watt power supply	$139.99	$128.99	KT1-C-2B	$269.99	$248.99
Tiger 767 AT Slot 1 with Sound & AGP video	**Celeron** up to 333MHz **Intel** Pentium II up to 500MHz	MB1-E-5A	$99.99	$91.99	BB1-E-5A AT Case 200 W Power Supply	$154.99	$142.99	KT1-E-5A	$249.99	$229.99
Tiger 760 Micro-ATX Slot 1 w/Sound & AGP video	**Celeron** up to 333MHz **Intel** Pentium II up to 500MHz	MB1-E-6A	$99.99	$91.99	BB1-E-6A Micro ATX Case 140W Supply	$139.99	$128.99	KT1-E-6A	$239.99	$220.99
Tiger 6KE LX ATX Slot 1	**Celeron** up to 333MHz **Intel** Pentium II up to 333MHz	MB1-T-10A	$49.99	$39.99	BB1-T-10A ATX Case 235W Supply	$114.99	$99.99	Not Available		
Tiger 6BE+ BX ATX Slot 1	**Celeron** up to 500MHz **Intel** Pentium II up to 500MHz	MB1-T-9A	$89.99	$79.99	BB1-T-9A ATX Case 235W Supply	$149.99	$134.99	Not Available		

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#CP2-K62-305	300	3DNow!	50-pack	$3,750.99	($75 ea)
#CP2-K62-333	333	3DNow!		$101.99	$96.99**
#CP2-K62-350	350	3DNow!		$116.99	$111.99*
#CP2-K62-380	380	3DNow!		$151.99	$144.99*
#CP2-K62-400	400	3DNow!		$187.99	$178.99*

IBM/Cyrix MII

From $47 Each in 50 Pack

Tiger recommends the AT motherboard or the Tiger Super Socket 7 motherboard with these processors.

IBM/Cyrix MII		1-2 Units	3 units or more
#CP2-6X300	MII 300 CPU	$50.99	$47.99
#CP2-6X305	MII 300 50-pack	$2,350.99	($47 ea.)
#CP2-6X333	MII 333 CPU	$57.99	$54.99*
#CP2-6X300	MII 350 CPU	$92.99	$87.99*

Intel Celeron & Pentium II MMX

Intel Celeron & Pentium II Processors		1-2 Units	3 units or more
#CP1-C1300	Intel Celeron **300** (no cache) processor	$49.99	$47.99
#CP1-C300A	Intel Celeron **300A** (128K cache) processor w/fan	$77.99	$72.99
#CP1-C333	Intel Celeron **333** (128K cache) processor w/fan	$102.99	$97.99
#CP1-P2-350	Intel Pentium II **350** processor w/fan*	$247.99	$240.99
#CP1-P2-400	Intel Pentium II **400** processor w/fan*	$417.99	$396.99
#CP1-P2-450	Intel Pentium II **450** processor w/fan*	$642.99	$610.99

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TCA-M-5A **ATX Server 6-Bay** 300-Watt Power supply. $89.99

abort. retry. fail?

THE LIGHTER SIDE OF PERSONAL COMPUTING

Edited by Don Willmott

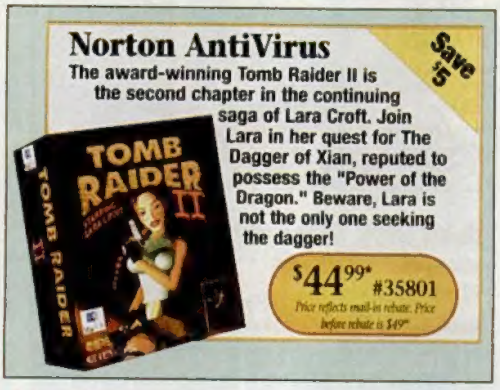
C'mon, boy! Fetch the joystick! (Canine Communications research photo.)

Rocky Mountain Redux

A clarification is in order. Six issues ago (December 1, 1998), ARF ran an item called "Rocky Mountain Pi," in which we featured a Denver newspaper report about how Aaron Blosser got into big trouble with the FBI for using U.S. West computers to attempt to solve a complex math problem. Mr. Blosser wrote in to point out that he didn't "hack" into the system and has yet to be charged with any crime. Noted.

Must-See TV

Faithful reader Lifeng Wu showed a friend how he could view TV shows on his PC screen. He turned the TV feature off and left the friend alone with the PC for a while, and when he came back, he found a series of DOS prompts on-screen with these commands: open TV, TV, hello TV, my TV, CNN, TV on, PC TV, television, good-bye TV.



Need to kill a virus? Lara Croft can handle the job. (MacMall catalog.)

File photo

Health shortcut: Give yourself a break from your computer.

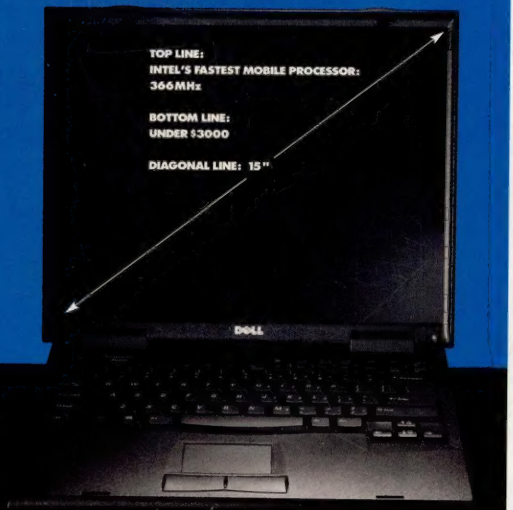
And here's another way to reduce stress: Get rid of your 18-year-old computer! (*Syracuse Post-Standard.*)

ARF on the Road: Montevideo, Uruguay, where it's cool to dangle your AOL disk from your rearview mirror.

"It says, 'Thank you for downloading Gumpton's Compression Utility shareware. Should you decide to purchase this product, send a check to the address shown and your PC will be uncompressed and restored to its original size.'"

If your entry is used, we'll send you $50 and a *PC Magazine* T-shirt. Send your entries to Abort, Retry, Fail?, *PC Magazine*, One Park Ave., New York, NY 10016-5802 or via e-mail to *don_willmott@zd.com*. Winners this issue: Steve Blind, Terry Kimbrough, Christian Salvarrey, and Lifeng Wu.

FOR TOP-LINE, BOTTOM-LINE AND DIAGONAL-LINE PEOPLE.



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